



Ri Aus

YOU CAN BE A SCIENTIST

STEM Careers Pack 1

Suitable for

Upper primary teachers

Careers counsellors

Year 7–9 science teachers



Government of South Australia

Department for Education and
Child Development

STEM careers

Introduction

The aim of each STEM Careers Pack is twofold: first, to make students aware of the wide variety of STEM careers there are and; secondly, to help students understand the nature of scientific knowledge, how science influences society and how society influences science (i.e. Science as a Human Endeavour).

During their explorations students will also appreciate how the different areas of science, technology, engineering and mathematics interact and are interdependent. They will develop their own STEM literacies and competencies.

Bringing STEM careers to life:

There is a current shortage of people, particularly women studying and working in STEM (also referred to in this unit as ‘science’). There are many factors at play supported by a substantial body of research; two of these factors are addressed in this unit. The first of these factors is that students find it difficult to identify themselves with scientists, mathematicians and engineers; they can’t picture themselves working in a STEM career¹. The second factor addressed here is that many students are simply unaware of the STEM careers available, what day to day work is entailed and what pathways lead into these careers².

Why is it important to address these factors in the middle years? Research has shown that experiences prior to 14 years of age are pivotal in developing students’ interests in science, and influencing career choices³.

‘When asked about when they became interested in science, 48 per cent of the students traced the origin of their interest to junior secondary school; 12 per cent mentioned primary school...’¹.

1. Office of the Chief Scientist 2012, *Health of Australian Science*. Australian Government, Canberra.
2. Panizzon, D & Westwell, M. 2009, *Engaging students in STEM-related subjects. What does the research evidence say?* Flinders Centre for Science Education in the 21st Century, Adelaide.
3. Tytler, R, Osborne, J, Williams, G, Tytler, K, Cripps Clark, J, 2008, *Opening up pathways: Engagement in STEM across the Primary–Secondary school transition*. Australian Department of Education, Employment and Workplace Relations, Australia.

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How to use this pack

Designed to be used:

- as a whole, but individual tasks can be selected;
- in conjunction with units of work on Science Understanding and Science Inquiry Skills

What do we want them to learn?

What is the intended learning?

It is intended that students will learn what common stereotypes, prejudices and perceptions exist regarding who can or should become scientists, where these beliefs and perceptions originate, whether or not they prevent people from taking up science pathways and whether or not students hold such beliefs in relation to themselves or others. The reasons why some people take up science pathways and others don't will be addressed, including a look at the lack of women in science and why this is of particular concern for government, industry and education. Furthermore, whether the lack of people, particularly women, is of concern to us individually and if so, what if anything ought we do about it.

Reaching a whole class consensus is not the intention of this unit of work. The focus is on engaging students in thinking about their own and others' beliefs and actions and engaging students in dialogue to understand these beliefs.



why is it important?

- We need individuals to be curious about the world and how it works.
- We need scientifically literate citizens
- We need a future supply of aspiring scientists, engineers and mathematicians both women and men.

What do students bring?

Students may come with their own beliefs and misconceptions about who scientists are and how they work, possibly with a limited understanding of how science impacts our lives, and even negative feelings, attitudes or anxiety toward studying and working in STEM. Students' research and critical thinking skills and dispositions will be further developed throughout this unit.

Planning approach

Planning approach based on the SA Department for Education and Child Development's Learning Design: aligning *what* and *how* of teaching and learning in the Australian Curriculum. www.decd.sa.gov.au/teachingandlearning/pages/Leadersresource/44209/?reFlag=1

Reference

Stereotyping, and Discovery and Invention sections have been adapted/reproduced with permission from the Institute for the Advancement of Philosophy for Children www.montclair.edu/iapc

Lipman, M., Sharp, A.M. & Oscanyan, F.S. (Eds) 1984, 'Philosophical Inquiry: An Instructional Manual to Accompany Harry Stottlemeier's Discovery', 2nd edn, University Press of America, Lanham, USA.

How will we know if they got it?

What could the intended learning look like at this level?

The *Australian Curriculum: Science* focus for this unit is **Science as a Human Endeavour**. Students will be able to identify and question stereotypes, prejudices and perceptions around who a scientist is, who can become a scientist and what a scientist's work entails. As well as identifying and questioning their own beliefs and those of others, students will understand why such beliefs should be openly questioned and how they can do this in a constructive, respectful manner. Students will be able to demonstrate an increase in their knowledge of science careers and pathways as well as the role of science in society.

Students' science inquiry skills specific to evaluation and communication will be further developed.

Teachers use the intended learning, as indicated in the Quick Reference table for this unit in conjunction with the Achievement Standards in the integration of the Tasks or the development of whole units of learning and assessment.

Students will demonstrate development towards the following Australian Curriculum skills and dispositions.

Australian Curriculum: Science Science as a Human Endeavour	Tasks					
	1	2	3	4	5	6
Year 7						
ACSHE119 - Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world.						
ACSHE120 - Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations.						
ACSHE121 - Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management.						
Year 8						
ACSHE134 - Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world.						
ACSHE135 - Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations.						
ACSHE136 - Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management.						
Year 9						
ACSHE161 - Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities.						
ACSHE228 - The values and needs of contemporary society can influence the focus of scientific research.						
The Personal and Social Competence Continuum: social awareness; and self-awareness						
The Ethical Behaviour Continuum: understanding of ethical concepts and recognising the moral domain; the knowledge of accepted values and ethical principles (specifically students' ability to critically analyse ethical principles).						
The Critical and Creative Thinking Continuum: inquiring, identifying, exploring and clarifying information; analysing, evaluating and synthesising information; reflecting on thinking, actions and processes.						

How will we know if they got it?

What evidence will enable us to assess the intended learning?

Science as a Human Endeavour

1. Students' knowledge and understanding of science in society (including a developing knowledge of science careers) and current issues surrounding the lack of people, particularly women, studying and working in science.
2. Students' understanding of the issues around the lack of people studying and working in STEM particularly girls/women, and what action individuals take and how successfully students execute their plans.

Personal and Social Competence and Critical and Creative Thinking

3. Students' ability and disposition to reflect on their own and others' beliefs.
4. Students' ability to participate in whole class discussion.

Ethical Behaviour and Critical and Creative Thinking

5. Students' ability to identify and critique stereotypes, prejudices and perceptions regarding science and to consider the possible impact of such beliefs.
6. Students' ability to engage in reasoned discussion with peers (in pairs, small groups and whole class), including the ability and disposition to draw on evidence when making informed decisions and to evaluate their own and other's reasons.

So, what will we do to get there?

How will we engage, challenge and support their learning?

Tasks will draw on students' prior knowledge, relate learning to students' everyday lives and provide opportunities for students to direct their own learning. Throughout the unit, students will be expected to:

- reflect on their own beliefs about who scientists are, what scientists do and who can become a scientist;
- analyse the origin of these beliefs and stereotypes and what impact these have on people's subject and career choices;
- engage in this reflection and analysis during whole class discussions, group activities and peer assessment tasks; and
- take a stand on the issue of stereotypes in science and, based on this stand, take action to combat these stereotypes.

Based on the SA TfEL¹ this unit focuses on the following Teacher Domains:

- 2.1 **Develop democratic relationships** – the teacher shares power with students recognising it as a fundamental condition for learning.
- 2.2 **Build a community of learners** – the teacher creates a culture where everyone inspires and encourages each other's learning.
- 2.3 **Negotiate learning** – the teacher responds to students' changing needs and involves them in deciding the direction of the curriculum.
- 3.3 **Explore the constructions of knowledge** – the teacher shows that knowledge is open to question, serves particular purposes and is shaped by culture and experience.
- 4.1 **Build on learners' understandings** – the teacher identifies students' prior knowledge and cultural practices as a starting point for curriculum.

1. South Australian Teaching for Effective Learning Framework (SA TfEL) www.decd.sa.gov.au/teachingandlearning/pages/Teaching/Teachlearnandassess/?reFlag=1

The terms 'understanding' and 'knowledge' are synonymous and thus used interchangeably throughout this unit.

A photograph of a diver underwater, wearing a black wetsuit, a yellow diving mask, and a pink glove. The diver is holding a yellow flashlight and looking towards the camera. The background is a deep blue ocean with a large, branching coral structure on the right side. A large white circle is overlaid on the right side of the image, containing the word 'TASKS' in blue capital letters.

TASKS

Pages

- Tasks
- 5–10 Task 1: Scientists at work
 - 11–14 Task 2
 - 15–17 Task 3: How do images, labels, slogans, stories and comments affect us?
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Task 1

Scientists at work

Australian Curriculum Links		
Year 7	Year 8	Year 9 ACSHE 161
Creative and creative thinking Personal and social competence		

Ask students to draw a picture of a scientist at work – they don't need to spend any time thinking about the task, just dive in and start drawing. Having finished their drawing, ask students to write (on the back of the page) as many jobs as they can think of that use science or are considered to be careers in science. Lastly, ask students to write down if they personally know a scientist, mathematician or engineer.

Pin the drawings up so students can see them all. As a class, take a critical look at these drawings. Put together a table representing and tallying the common features and (eg. how many have wild hair, glasses/safety glasses, lab coat). Use this tally to generate discussion around the similarities and differences; such as the number of male vs female scientists and how many drawings show the scientists working alone in a laboratory.

Note: use the word 'stereotypes' sparingly as it can have negative connotations. Instead you can use other words where appropriate such as beliefs, perceptions and prejudices.

Following the tally of common features and discussion you could raise the following points:

- What we have been talking about here, these common features, are they true of all scientists or only some scientists? How do you know this? What about scientists today, compared with scientists in the past?
- So, when I asked you to draw me a picture of a scientist at work, what you drew (generally speaking) was based on your beliefs about who scientists are and what they do. But these beliefs may only be true or accurate for some scientists, not all. These 'generalised beliefs' imply that all people or objects in a particular group are all the same. For example, all tall people make great basketball players. Or, all doctors can't write neatly. Such beliefs or claims are not always true.



- Humans, and other animals, hold generalised beliefs about a lot of different things and often these beliefs are very helpful. You might believe that a stranger on the street, walking along swinging a knife, for example, should be avoided because he or she might be dangerous. Just like a bird might 'believe' that a squiggly looking object on the ground (shaped like a snake) should be avoided because it is dangerous. Such generalised beliefs in these instances help to keep us safe and save us the hassle of testing out each new situation (and risk harming ourselves or others). (Ask the students to think of other examples.)

Encourage the students think about their own beliefs in relation to who scientists are and what they do. Foster an open discussion in a safe environment where peers are listened to and questioned rather than talking over the top of one-another and jumping to conclusions (making assumptions).

Keep the students' drawings for Task 7.

Task 1

Part 1: Stereotyping

There are two major forms of stereotyping.

The first goes like this: you are a member of a group. Some members of the group are known to have a certain trait. It is therefore inferred that you, too, possess that trait. E.g. “Oh, you’re British, you must be reserved!” or, “Oh, you’re Italian, you must be very expressive!”

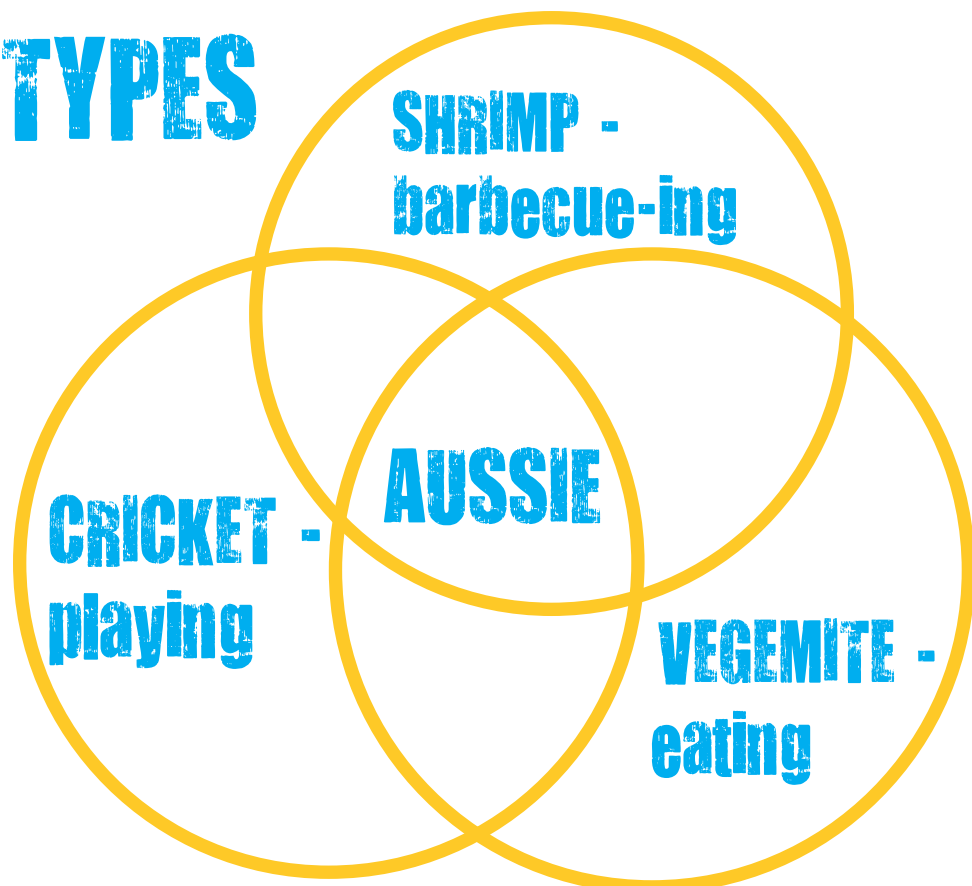
The second is as follows: you are known to have a certain trait. You are therefore classified with a group of individuals, only some of whom share that trait. E.g. “You’re so reserved, you must be British!” or “You’re so expressive, you must be Italian!”

What makes stereotypes so mischievous is that they are often so plausible. Like half-truths, they are based on some evidence, but not on sufficient evidence.

Ethnic humour tends to cultivate the fallacies on which ethnic stereotypes are based – even when these jokes are made by the ethnic group in question, and at its own expense. Perhaps the only grounds, if any, for tolerating such humour is that it represents a safety valve for “letting off steam”, i.e. for ventilating vague prejudices and ill-founded suspicions which, if repressed, might eventually issue in more damaging forms of behaviour.

The following exercise (stereotyping) will help students think through the reasoning mistakes being made in the examples. Then ask students to go back to their own drawings of scientists and think whether they themselves were making any of these same reasoning mistakes.

STEREOTYPES



Lipman reference

Lipman’s resources have many exercises to develop students’ reasoning abilities and disposition.

Lipman, M., Sharp, A.M. & Oscanyan, F.S. (Eds) 1984, ‘Philosophical Inquiry: An Instructional Manual to Accompany Harry Stottlemeier’s Discovery’, 2nd edn, University Press of America, Lanham, USA.

www.montclair.edu/iapc

Task 1

Part 1: Stereotyping

In the following examples, decide whether or not the case in point is an instance of faulty reasoning. If you think the reasoning is faulty, give a reason for your thinking so.

Example	Faulty/Okay Reasoning	Why I think it's faulty
Andy says: "Boys are aggressive. The star player on the girls' volleyball team is very aggressive. I'll bet she's really a boy."		
Daisy says: "Jim's stingy. And everyone knows car dealers are stingy. So Jim must be a car dealer".		
Eddie says: "My uncle Frank is from Texas. He must be a cowboy".		
George says: "I'm timid. Lots of girls are timid. I must be effeminate".		
Jehad says: "Many students who get A's are fast readers. But I'm a slow reader. So I guess I'll never get A's".		
Dominic says: "All the parts of this machine are made of metal. This is a part of the machine, so it must be made of metal".		
Joe says: "Any drop of water can freeze. This isn't a drop of water. So it can't freeze".		
Sarah says: Queenslanders live near New South Wales. Henry doesn't come from Queensland so he must not live near New South Wales".		
Travis says: "I think lots of criminals are fascinating. Ned Kelly was a criminal, so he must be fascinating".		
Dora says: "All the parts of this cupboard are made of wood. This is a piece of wood. It must be part of this cupboard".		

Task 1

Part 1: Stereotyping

(answer sheet)

Example	Reasoning Faulty/Okay	Why I think it's faulty
1. Andy says: "Boys are aggressive. The star player on the girls' volleyball team is very aggressive. I'll bet she's really a boy".	Faulty	Andy confuses "All boys are aggressive" with "Only boys are aggressive". Surely there are boys who are not aggressive and girls who are.
2. Daisy says: "Jim's stingy. And everyone knows car dealers are stingy. So Jim must be a car dealer".	Faulty	Daisy confuses "All car dealers are stingy" with "Only car dealers are stingy" Even if all car dealers were stingy, Jim could still have a different job.
3. Eddie says: "My uncle Frank is from Texas. He must be a cowboy".	Faulty	Eddie must think all Texans are cowboys. Not so, of course.
4. George says: "I'm timid. Lots of girls are timid. I must be effeminate".	Faulty	Lots of girls aren't timid, lots of boys are.
5. Jihad says: "Many students who get A's are fast readers. But I'm a slow reader. So I guess I'll never get A's".	Faulty	Many slow readers are excellent students.
6. Dominic says: "All the parts of this machine are made of metal. This is a part of the machine, so it must be made of metal".	Okay	
7. Joe says: "Any drop of water can freeze. This isn't a drop of water. So it can't freeze".	Faulty	This is an odd variant, but it occurs frequently enough. It can be formalised as follows: All members of group X have trait Y This is not a member of group X Therefore is doesn't possess trait Y The error in assuming that "All members of group X have trait Y" is equivalent to "Only members of group X have trait Y."
8. Sarah says: Queenslanders live near New South Wales. Henry doesn't come from Queensland so he must not live near New South Wales".	Faulty	The same as number 7. The fact that <i>all</i> Queenslanders live near New South Wales does not exclude the fact that Queenslanders aren't the <i>only</i> ones who do.
9. Travis says: "I think lots of criminals are fascinating. Ned Kelly was a criminal, so he must be fascinating".	Faulty	If Travis thought all criminals were fascinating, his reasoning would be okay. But if he merely thinks <i>most</i> are, his conclusion doesn't follow.
10. Dora says: "All the parts of this cupboard are made of wood. This is a piece of wood. It must be part of this cupboard".	Faulty	See 7 above. If the first premise were "Only this cupboard is made of wood" then there would be some grounds for the inference. But even then it would be very shakey; there could be many pieces of wood that weren't parts of the cupboard.

Task 1

Australian Curriculum Links		
Year 7 ACSHE 120	Year 8 ACSHE 135	Year 9 ACSHE 161

Part 3: Career interviews



JING
Image Specialist
GIS (Graphic
Information Systems).



KATHRYN
Marine Biologist
(algae specialist).



SHIRLEY
Marine Biologist
(sponge specialist).



HELEN
Biologist
(animal classification
specialist).

There are many ways you can use this interview footage. The following are suggestions for whole class, small group or pair activities.

Activity suggestions

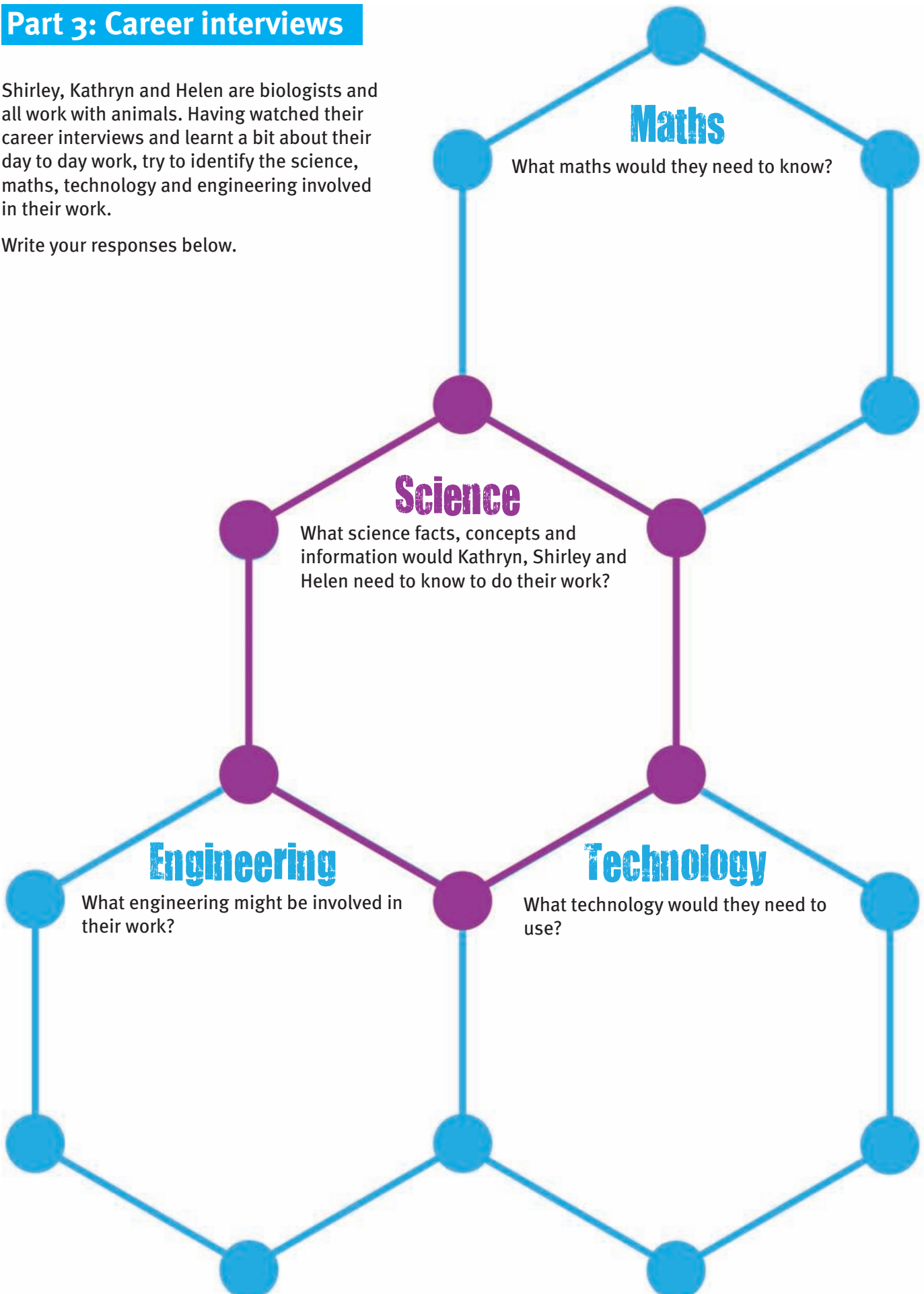
1. Students watch the footage and make notes about: what area each person works in and what their specialty is; how they became interested in their area of work and when this interest began; and what they like about their jobs.
2. What is Helen's speciality? If you were a biologist would you focus on animals or something else? Why? (In considering this question you might need to find out more about what a biologist does.)
3. What do Shirley and Kathryn specialise in? If you were a marine biologist what would you like to specialise in? Why? (In considering this question you might need to find out more about what a marine biologist does.)
4. Helen, Shirley and Kathryn are all biologists of some description; what is the difference?
5. Kathryn talks about her work contributing towards the development of sustainable seafood. Why is it important that people, including biologists, work towards finding sustainable seafood or food options?
6. Shirley mentions using the chemicals in marine sponges for medical drugs. What sort of diseases are scientists trying to develop drugs for using marine sponges (also known as 'sea sponges')? Are there any drugs in use today that were developed from marine animals or plants?
7. Helen talks about classifying animals and managing information on different animal species and their locations. Why is this work important? How will this information help us in the future?
8. What other current issues or problems are there in the world that you think animal or marine biologists could help solve?
9. Would you like to be a marine biologist, a biologist working with land animals, or would you like to make 3D maps? Why/Why not?

Task 1

Part 3: Career interviews

Shirley, Kathryn and Helen are biologists and all work with animals. Having watched their career interviews and learnt a bit about their day to day work, try to identify the science, maths, technology and engineering involved in their work.

Write your responses below.



Task 2

Australian Curriculum Links		
Year 7 ACSHE 121 ACSHE 120	Year 8 ACSHE 135 ACSHE 136	Year 9 ACSHE 161 ACSHE 228
Critical and Creative Thinking		

Part 1: Science that has made an impact on our lives

Ask students to think about an invention, a product, medicine, or a discovery that has had an impact on their lives. Make a list on the board and have students give a brief explanation as to what the impact has been (perhaps their lives have been improved, made easier or more fun). Encourage students to think of minor, everyday impacts as well as those all-pervasive impacts such as smartphones, including local and global impacts. Make sure that there is at least one invention/product/discovery from your local area or state/territory, one from an Aboriginal Australian, a woman, and a person who came from a non-science background. Divide small groups of students amongst the suggested inventions/ products/ discoveries (or at least a selection of them). Give students as much choice as possible.

Have groups research their invention/ product/ discovery and present their findings in writing (e.g. poster, report).

- How important is this invention/ product/ discovery to our lives? How have our lives been changed?
- Has the invention/ product/ discovery significantly changed people's (including your own) understanding of the world?
- Who is the scientist or group of scientists behind it? What do you know about them personally?
- How did they work – alone in a lab? In a group? Outdoors?
- What is one really interesting/exciting thing about these scientists and their work?
- Pose and answer a question of your own choice.

It will be up to you, as the teacher, to assume responsibility for making the students in your class fully conscious of the thrill of discovery and invention. What you will in fact be doing is reminding them: there is no child who has not experienced this thrill. But in all likelihood, the children in your class have not reflected upon what it is that makes discovery so exciting.

Lipman, M., Sharp, A.M. & Oscanyan, F.S. (Eds) 1984, 'Philosophical Inquiry: An Instructional Manual to Accompany Harry Stottlemeier's Discovery', 2nd edn, University Press of America, Lanham, USA.

Part 2: Discovery and invention

It may be that your students are already exploratory; in that case you are simply getting them to reflect upon what they are doing. Or, your students may be timid and feel very inhibited about investigating the world of things and ideas; these children need to be reassured as to how wholesome and wonderful discovery and invention can be.

Part A: For each statement tell whether you think it describes an 'invention' or a 'discovery'.

1. Captain Cook finds Australia.
2. John comes upon Mary's lost book, lying on the floor.
3. James thinks up a new way to string beads.
4. A scientist doing research finds out how human cells can become cancerous.
5. A family makes a new device that automatically feeds the dog while they are away from home.

Part B: In your own words describe the difference between the actions you call 'discovery' and those you call 'invention'.

Part C: Read the definitions given here.

Discover

– to find out, realise, learn of the existence of.

Invent

– to think up, devise, think out, produce, originate.

In each of the sentences below choose one or both words.

1. A famous explorer was responsible for the (discovery, invention) of the Pacific Ocean.
2. The (discovery, invention) of the printing press made it easier to publish books.
3. Scientists try to (invent, discover) ways to save energy.

Part D: Discuss your answers to Part C.

Task 2

Part 2: Discovery and invention



Part 1:

What does it mean to discover something? What does it mean to invent something? What have humans discovered and what have we invented? Think about the list below and decide whether each is an invention or a discovery and explain why.

	Discovery	Invention	Reasons
1. Electricity			
2. Electric light bulbs			
3. Magnetism			
4. Magnets			
5. Papyrus			
6. Television			
7. The South Ocean			
8. X-rays			
9. Soap			
10. Computers			
11. Thinking			
12. The family			
13. The city			
14. Pasteurised milk			
15. Iced coffee			

Part 2: Have your students write a paragraph on one of the following topics:

- My greatest discovery
- The difference between discovery and invention
- What I'd like to invent
- Can people discover things together?
- Are all discoveries inventions?
- Are all inventions discoveries?

Task 2

Part 3: Formulating if ... then ... hypothesis. Key points.

In everyday conversation we talk about ALL cats having four legs and EVERY square having four corners, but when testing these sorts of claims in science, they are often converted to **if...then...** statements known as hypotheses.

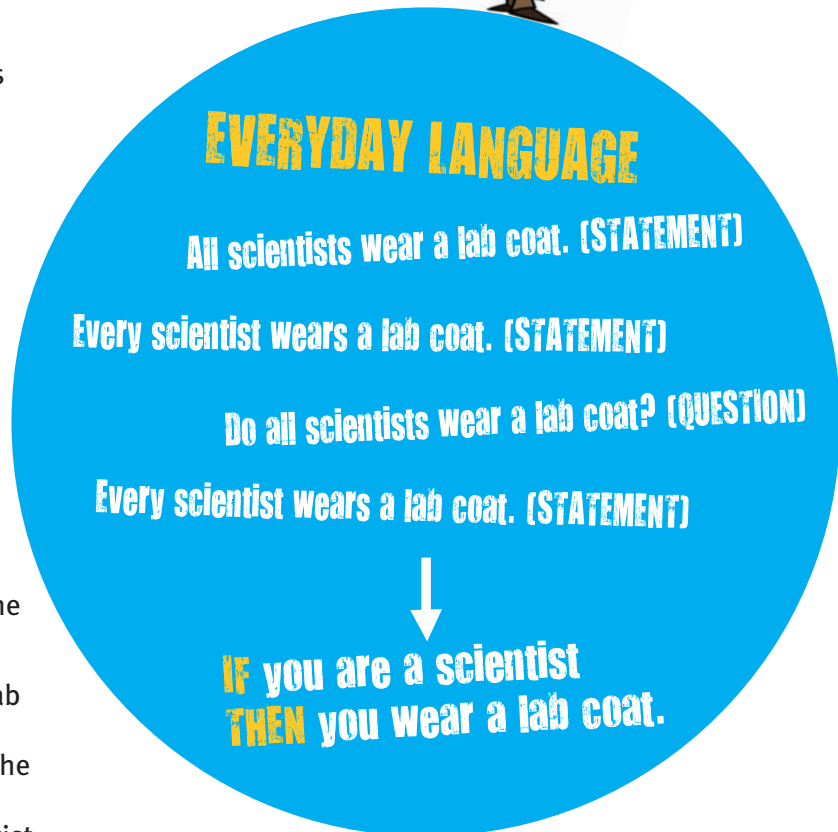
From the discussion of common features found in student's drawings of 'scientists at work', students can formulate **if...then...** statements and then test the truth of these claims.

For example, in the students' drawings every scientist is wearing a lab coat. This raises the question, do students think that all scientists wear lab coats. Is this true? Do all scientists wear lab coats?

In order to answer this question scientists would commonly turn the question (or a statement) into a prediction that can then be tested. This prediction would be stated as an **if...then...** statement; known as a hypothesis. Scientists would then go about testing the hypothesis using experiments and ultimately finding an answer to the question, do all scientists wear lab coats?

To formulate the question, 'do all scientists wear lab coats?' as a hypothesis separate the two variables (1) scientists and (2) wearing lab coats, and place the first variable after **if** and the second variable after **then**. The hypothesis now reads: **if you are a scientist then you wear a lab coat**. So, 'if you are scientist then you wear a lab coat' is equivalent to 'all scientists wear lab coats.'

All hypotheses will contain at least two variables; at least one independent and one dependent variable. Distinguishing between and identifying these two types of variables is often a difficult task for students. Practice is the key. Here are a few points that will also help.



Definition: the independent variable is what a scientist changes and scientists look at the dependent variable to see if the changes made have had an effect.

Independent variable: is what you do, the cause, the input.

Dependent variable: is what happens, the effect, the output.

Tip – your hypothesis can tell you what your variables are. For example: If I go outside without an umbrella, then I won't get rained on. The first variable is the independent variable, the second is the dependent variable. If I go outside without an umbrella (independent variable), then I won't get rained on (dependent variable).

Task 2

Part 4: Where do all these beliefs about science come from?

Australian Curriculum Links		
Year 7 ACSI5 121	Year 8 ACSHE 136	Year 9 ACSHE 161 ACSHE 228
Personal and Social Competence Critical and Creative Thinking		

Following on from Task 1, you want students to start thinking about where these ‘common feature’ ideas or beliefs have come from. Start by asking students when they learnt what science is and what scientists do? How did they learn this? Did someone tell them, did they read about it, see something on TV? Can students remember some images/words/slogans/stories/comments that might have influenced their beliefs about science? This may take students some time to think about and may generate some interesting discussion.

Now, have the students in small groups look for evidence of images, labels, slogans, stories that could influence people’s beliefs about who scientists are and what they do.

Students should search the classroom, science lab, school, TV, internet, adverts, and even engage adults and peers in conversation about science. Students should gather these images, labels, slogans, stories, and comments to be used in Task 3.

Suggestions for Assessing Task 2 – Formative – monitor students’ understanding of science ‘stereotypes’, students’ ability to critically analyse messages in images, text, comments, their ability to recognise and evaluate opinions different to their own and articulate their own beliefs and questions while working in small groups. Give feedback to develop this understanding and these skills.



Task 3

How do images, labels, slogans, stories and comments affect us?

Australian Curriculum Links		
Year 7 ACSHE 120	Year 8 ACSHE 135	Year 9 ACSHE 161
Personal and Social Competence Critical and Creative Thinking		

What you want the students to discuss now is whether images, labels, slogans, stories, and comments about who scientists are and what they do are encouraging or discouraging people (including themselves) from taking up science pathways.

Remind students that in Task 1 you raised the point that humans and other animals hold some generalised beliefs which are helpful. You could ask students to remember some of the examples discussed. Here students will start thinking about how generalised beliefs about science could be unhelpful, could discourage people from taking up science pathways.

Collate the groups' findings from Task 2 on the board or wall under one of three headings: encouraging people into science/ discouraging people from science / not sure. Take an advert for toothpaste for example; students will need to say why they think it encourages or discourages people from science or why they are unsure. Essentially, students are articulating the messages they glean from images, text, comments they have found.

- Rotating through the groups, have students place an image/text/comment under one of the headings and give at least one reason for its placement (write reason next to finding). Work through all the findings in this way.
- The reasons can then be turned into questions that are put to the students to answer (either as part of this ongoing discussion or following)
- Once all findings have been sorted, take those under the **Not Sure** column and try again to place them. If they can't be placed it may be that the class needs to gather more information (this should be followed up at an appropriate time).
- If there are any findings which the class is still 'divided' over these can be placed on the dividing line and a comment recorded.
- Raise any important points that students may have missed, such as: What if there are no pictures of Australian Aboriginal and Torres Strait Islanders in the images? What if there are few girls shown as scientists? Some students might not have anyone in their family who has gone to university... how do you think they might feel seeing and hearing these sorts of things? What about students who grow up living in the country or outback... do you think they would feel encouraged or discouraged? (These questions address the profiles of students least likely to take up science pathways.) See overleaf.

what DO I think about the science in this?



Task 3

Example

Australian Curriculum Links		
Year 7 ACSHE 120	Year 8 ACSHE 135	Year 9 ACSHE 161
Personal and Social Competence Critical and Creative Thinking		

ENCOURAGING PEOPLE INTO SCIENCE

DISCOURAGING PEOPLE INTO SCIENCE

NOT SURE



people working together

looking happy doing that work.

Follow-up question for students

- Do scientists work together in teams sometimes?
- Do scientists work with other scientists or all sorts of people? Do we need to research science jobs to answer this?
- Can you be happy working as a scientist?
- Are all people happy with their jobs?
- Do you have to be happy at work/your job everyday?



crazy-looking scientist

lots of pictures show scientists as old men; grey hair and glasses with a lab coat.

Follow-up question for students

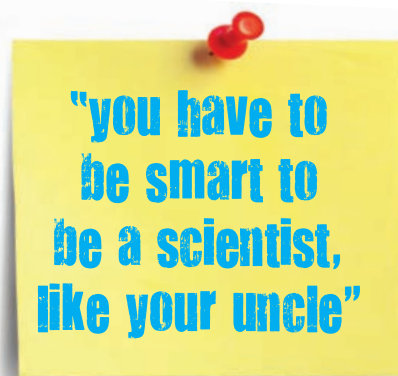
- Do all scientists look like this?
- Is it only scientists on TV and in the media who look like this? Are there a few in real life?



Being a nerd is a bad thing. Nobody wants to be called a nerd.

Follow-up question for students

- Is it 'bad' to call someone a nerd?
- What does being a nerd mean? Is 'geek' the same?
- Can you mean this in a funny way?
- Should we just not use it at all in case we offend someone?
- Is only science for nerds? Are 'other things' for nerds too?
- What if someone calls themselves a nerd?



This might make you try harder, or you might just give up, if you don't think you can be or are smart enough at science.

It's not so bad to be called a nerd anymore. People say it all the time in a funny, friendly way.

Follow-up question for students

- Are you born smart or can you become smart?
- How can you become smart?
- Is it helpful to want to be like someone, or is it too much pressure?

Task 3

How do images, labels, slogans, stories and comments affect us?

Australian Curriculum Links		
Year 7 ACSHE 120	Year 8 ACSHE 135	Year 9 ACSHE 161
Personal and Social Competence Critical and Creative Thinking Ethical Behaviour		

What is important here is that students practice giving reasons and evaluating their own and others' reasons. This is an important set of skills and disposition to develop in students, in relation to science and everyday life.

Make sure that students are able to make the connection between generalised beliefs about scientists and science, where these beliefs come from and how they encourage or discourage people. For example, one might believe that in order to become a scientist you need to find science easy. Parents or family members might say this and therefore because a student finds science hard then she believes she shouldn't become a scientist. (Teachers will recognise that this belief is also tied up with students' own theories of knowledge.)

The questions arising from students' reasons are very important; they are getting at the heart of the students own beliefs about science. Addressing these questions is where misconceptions can be dispelled, theories of knowledge discussed and progress made in developing students' metacognition.

Following the discussion ask students to demonstrate their understanding of the issues by writing a response the following questions. The responses could be discussed as a class:

1. How do you feel about learning science and even becoming a scientist? Explain why?
2. Are you encouraged or discouraged by the images, labels, slogans, stories, comments around you? Why/why not?
3. If these images, labels, slogans, stories, comments do discourage you or other people from being interested in science, should we do something about them? Why/why not? If yes, what should we do?

For tips on how to run a successful whole class guided discussion (also known as a Community of Inquiry) see:

- Institute for the Advancement of Philosophy for Children
www.montclair.edu/cehs/academics/centers-and-institutes/iapc/
- Splitter, L. & Sharp, A. M. (1995), Teaching for Better Thinking: The Classroom Community of Inquiry, Melbourne: ACER.
- DeHaan, C., MacColl, S. & McCutcheon, L. (1995). Philosophy with Kids, Book 3, Hawthorn: ACER, pp 13-17.
- Cam, P. (1995). Thinking Together, Sydney: Hale & Iremonger, pp 41-54.
- Hawaii P4C 'Philosophy for Children, a Guide for Teachers', Dr. Thomas Jackson
www.p4chawaii.org/resources/getting-started

Suggestions for Assessing Task 3 – Formative – monitor students' understanding of science 'stereotypes', students' ability to critically analyse messages in images, text and comments, their ability to recognise and evaluate opinions different to their own and articulate their own beliefs and questions while working as a whole class and give feedback to develop this understanding and these skills.

Task 4

Is science a girl thing?

Australian Curriculum Links		
Year 7 ACSHE 120	Year 8 ACSHE 135	Year 9 ACSHE 161
Personal and Social Competence Critical and Creative Thinking Ethical Behaviour		

In June 2012 an advert (campaign teaser) enticing girls into science went viral and caused a heated debate amongst scientists and science communicators around the world. The advert was a teaser for the European Commissions' new campaign – Science: It's a girl thing! Many of those who posted comments and YouTube clips in response argued that the clip was derogatory and sexist. But at the same time one has to note that many of those who spoke out are not the intended target audience – so what does the target audience say? The advert was aimed at girls between 13 and 17 years old who are disengaged with science or at least not sure about studying science.

Have students watch the advert:

www.youtube.com/watch?v=go32MPrSjFA

then go immediately into the discussion plan below (ideally as a whole class discussion). **Note:** if you are unable to watch this specific advert you could find another stimulus to raise the same or similar points and adjust the discussion plan accordingly. For example, you could use a segment from a TV show, advert or a photograph.

The word 'stereotypes' is used here as it has negative connotations and the following discussion engages students in thinking about the negative effects of stereotypes. You could explain 'stereotypes' as harmful.

Discussion: Is the clip *Science: It's a girl thing!* breaking the

stereotype?

(Dashes are notes for teachers, dots are anticipated student responses)

1. What did you think of the advert?
 - Keep students' comments brief simply to allow the discussion to develop and for those who need time to think to have that time



2. What does the advert say to you, what is the message you get from it?
 - That science is for girls/ you don't have to be a boy or a tomboy
 - That you can be pretty and like science/ be a scientist
 - That there is science in the things that girls are interested in like makeup
 - That science can be fun
 - That boys gawk at good looking girls
 - That girls are giggly and only interested in fashion and looking good
3. What message do you think you were meant to get from the advert?
 - (Same as above)
 - (Perhaps something different)
4. Who do you think is meant to find the advert appealing? In other words, who do you think it's aimed at? Why/why not?
5. Are there stereotypes, general beliefs that are discouraging, shown in this advert?
 - This will give the students a chance to debate some of the ambiguity about what may or may not be a stereotype
6. Is it okay that the male scientist looks up as he does when the girls walk in? Why/why not?
 - Here the students are thinking about the morality of the action – whether or not it is morally okay to show the male looking at the females in this way. Students may talk about the action being sexist which indicates their belief that the action is morally wrong. This is one action in the advert that has been contentious along with the giggling and makeup references.

Task 4

Discussion: Is the clip *Science: It's a girl thing!* breaking the stereotype?

7. Is it okay that the female scientists were giggling? Were all dressed up? Why/Why not?
 - As above
8. Is it okay to include makeup images in an advert about studying and working in science (nail polish, lipstick)? Why/why not?
 - As above
9. Do you think these images would discourage or encourage girls from thinking about studying and working in science? Why/Why not?
 - Girls in the class can talk about whether or not the advert encourages them personally
 - Perhaps it is intimidating that the girls are both into science and pretty? Perhaps a similar image of boys who were into science and handsome would be equally intimidating for boys
10. Do you think this clip would cause people to think things like
 - all girls should be beautiful and giggly and all boys should be handsome and smart
 - when society is trying to stop people holding these beliefs, these harmful stereotypes? Why/why not?
 - Some students might want to argue that the images aren't particularly harmful or not harmful at all, others might disagree saying that they perpetuate all the old fashioned beliefs about what girls and boys should look like, their interests and what they should do for jobs, that the images don't show the females as serious scientists
 - Others might argue that the advert is trying to encourage girls who are currently more interested in fashion and looking good to get interested in science, that they can actually be interested in both
 - Some students may argue that if people think about adverts in the way they have here that the harm such images might cause is lessened or disappears altogether.

Here you could show students the European Commission's website *Science: It's a girl thing!*

Allow students to explore the sites content. www.science-girl-thing.eu. Students should relate this discussion of the advert to the website content.

11. This advert was pulled off the website because lots of people complained about it. Do you think that the advert should have been pulled off? Why/why not?
 - Yes it should for the harm it causes as outlined in the discussion (perpetuating stereotypes...)
 - No it shouldn't because it doesn't cause any harm
 - Maybe/maybe not because it has at least got people talking about stereotypes in science and STEM and gets lots of people looking at the advert and the website.



Task 4

Discussion: Is the clip *Science: It's a girl thing!* breaking the stereotype?

Here you could show students this advert for the Ford Territory: www.youtube.com/watch?v=19o2pNJHgoQ

12. What are the similarities and differences between how Jessica is shown in this advert and the girls in the *Science: It's a girl thing!* advert?
 - Make sure students give their reasons
13. What does this advert 'say' about female engineers or female scientists in general?
14. Will this advert encourage or discourage girls to study and work in science and engineering? Why/why not?

Suggestions for Assessing Task 4 - Formative - monitor students' understanding of the term 'stereotypes' and how such stereotypes can be harmful, the ability to recognise a science stereotype and give feedback to develop these understandings. Monitor students' ethical reasoning capability and critical literacy skills and give feedback to extend this learning.

Note: the resources listed above in relation to whole class discussions also include ideas for assessing students' discussion and reasoning skills. For example, you might assess students': ability to listen, to ask questions, to clearly articulate their reasons, to ask others for reasons and clarification, to disagree without anger, to take turns at speaking, to build on the ideas of others, to relate own ideas to the ideas of others, to summarise, to provide examples.



Task 5

Few people, particularly women, are going into science

Australian Curriculum Links		
Year 7 ACSHE 121	Year 8 ACSHE 136	Year 9 ACSHE 228
Personal and Social Competence Critical and Creative Thinking Ethical Behaviour		

Students may already be aware of or have come to realise that there is a big push for more people to study and work in science, particularly a push for women who represent only a small portion of the science (and STEM) workforce. If they are not aware, you could introduce students to some of the current statistics (see the list of Useful Websites: Reports and Articles, below) or have students do a quick internet search on the topic of jobs in science or females and science. The lack of people in science, particularly females, is currently a significant concern of government, education and industry, and all involved are working to increase the number of people studying and working in STEM. However, in order for us to understand why the lack of people, or of females more specifically, in STEM is something to be concerned about, we need to ask ourselves: does it even matter that there are few people and few women working in STEM careers and studying STEM subjects? This is the next question for students to think about.

(Dashes are notes for teachers, dots are anticipated student responses)

Does it matter that there are not enough people studying and working in science (STEM) jobs? Why/why not?

- Students might be able to answer this question based on what they learnt thus far. If not, then set a research task to answer this question.
 - This is a growing industry area and so we need people to work in it
 - Society needs science and if we don't have enough scientists how will we survive?
 - If we have lasted this long, surely we'll be okay?
 - What about those qualified scientists who aren't able to get science jobs; doesn't this show we don't need more?
 - Can we just bring in scientists from overseas?
 - We can't force people to do science... or should we be doing this if it's so important?
- These questions are genuine questions that society is grappling with and so are well worth discussing in the classroom, even though a definitive answer or consensus is unlikely. Students will be thinking about the importance of science in society and developing their reasoning skills.



Hear what scientists and engineers have to say about women in STEM. The comments could be used to raise points for discussion.

Does it matter that there are fewer women than men studying and working in science (STEM)? Why/why not?

- Students might argue either way, what is important here is for students to articulate and evaluate the reasons given
 - If there are people working what does it matter if they are girls or boys
 - So long as there are equal opportunities to get into STEM jobs it doesn't matter if not as many girls take the opportunity
 - We need to have the input of girls too, not just boys – if both males and females use the things that are designed and developed then both should have a part to play in the design and development of those things -why though?
 - Women might have different ideas and be able to take a fresh look at old problems

Assessment of Task 5 – Summative

Peer Assessment: as a class, prior to students engaging in the task, develop a set of clear criteria against which the students will assess each other's posters/written reports. For those classes new to providing critical feedback the 'two stars and a wish' method or a similar tool to help guide the students would be advisable. Look for evidence of the extent to which students understand that 'science and technology contribute to finding solutions to a range of contemporary issues' (ACSHE120 & ACSHE135 Years 7 & 8), that 'advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities' (ACSHE161 Year 9). Give feedback to foster these understandings.

Task 6

Taking a stand

Students should by now have grasped some understanding of what generalised beliefs there are around science and the notion that some of these misconceptions or stereotypes may discourage some people from study and work in science. Building on what the students have learnt thus far regarding the harm of stereotypes in science and the lack of people, particularly females, students are to adopt a stand and take some sort of action on this issue.

Depending on how important and how immediate students' consider the issue of getting more people into science will dictate the type and level of action they would like to take. In deciding this, a great deal of discussion may happen amongst students; like-minded students could work together on taking action.

The action could be:

- a poster depicting women working in STEM jobs that can be placed around school
- a slogan speaking out against science stereotypes that can be used around the school
- a video clip showing all the different sorts of work that scientists do which can be played at assembly or on the intranet
- writing letters to organisations/parliamentarians in support of encouraging females into STEM careers
- arranging for a local STEM organisation/industry to speak about their work at school to encourage all students to consider that career
- arranging for Speakers in Schools, Scientists in Schools or Mathematicians in Schools to bring a speaker to the school and even work with students on an on-going basis.

This task may involve students viewing other STEM campaigns (there are many online), researching what STEM education/careers/training are available, and what various STEM careers involve (eg. such as 'a day in the life' clips of people at work).

Australian Curriculum Links		
Year 7 ACSHE 119 ACSHE 120	Year 8 ACSHE 134 ACSHE 135	Year 9 ACSHE 161
Personal and Social Competence Critical and Creative Thinking Ethical Behaviour		

Assessment Task 6 – Summative – look for evidence of the extent to which students understand that 'some scientific discoveries have significantly changed people's understanding of the world' (ACSHE119 & ACSHE134 Years 7 & 8), that 'science and technology contribute to finding solutions to a range of contemporary issues' (ACSHE120 & ACSHE135 Years 7 & 8), that 'advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities' (ACSHE161 Year 9). Give feedback to foster these understandings. There are also strong links with the general capabilities: Personal and Social Competence, Ethical Behaviour, Critical and Creative Thinking and Literacy. Give feedback to foster these capabilities.

Task 7

Personal reflection

There are a number of options here to engage students in a reflection of the tasks they have completed. You could use some or all of the following options.

Ask students:

- To again draw a scientist at work and a list of all the science careers they know of – using the same conditions as in Task 1. Have students compare their original drawings and lists to those produced here. This could be done as a class or individually. Students could write a response to why they think their drawing has changed or not and how many more science jobs they are now aware of.
- To write 5 or more dot points outlining the key points addressed in this unit
- If they have any questions they still want answers to in relation to this unit of work?
- If this unit inspired them to want to do some more research on a particular area/topic/idea?
- If there is a particular science career that students would like to look into.

Resources

Useful websites

- ABC Ace Day Jobs www.abc.net.au/acedayjobs/
- ‘Do you enjoy or are you good at’ posters www.myfuture.edu.au/assist%20Others/Activities/Bullseye%20posters.aspx
- European Commission – Science: It’s a girl thing! <http://science-girl-thing.eu/>
- Ford Territory advert www.youtube.com/watch?v=19o2pNjHgoQ
- Interviews with Australian scientists www.science.org.au/scientists/alphabetical.html
- L’Oreal Foundation For Women in Science Australia & New Zealand www.scienceinpublic.com.au/loreal/
- My Future www.myfuture.edu.au/
- SA Government – Skills for All: Skills most needed in South Australia www.skills.sa.gov.au/careers-jobs/choosing-your-career/-skills-most-needed-in-south-australia
- SA Government – Skills for All: search careers and industries www.skills.sa.gov.au/careers-jobs/choosing-your-career/search-careers-and-industries?i=13
- SA STEM Skills Strategy for SA www.dfeest.sa.gov.au/Portals/1/Documents/science/STEM_Skills_Strategy_for_South_Australia.pdf
- Scientists/Mathematicians in Schools www.scientistsinschools.edu.au/
- Science: It’s a girl thing! advert <http://www.youtube.com/watch?v=go32MPrSjFA>
- Speakers in Schools www.speakersinschools.com.au/
- This is what a scientist looks like lookslikescience.tumblr.com/

Relevant articles/reports

- Engaging students in STEM-related subjects. What does the research evidence say? www.flinders.edu.au/science_engineering/science-21-files/briefings/Engaging%20students.pdf
- EU campaign makes science and innovation a ‘girl thing’ europa.eu/rapid/pressReleasesAction.do?reference=IP/12/633
- ‘Fed-up’ women ditching science careers www.abc.net.au/news/2011-04-11/fed-up-women-ditching-science-careers/2619442
- Female Topics Encourage Girls to Study Science, Study Finds www.sciencedaily.com/releases/2011/02/110216083242.htm
- Health of Australian Science report – Australia’s Chief Scientist Report www.chiefscientist.gov.au/2012/05/health-of-australian-science-report-2/
- Our top female scientists honoured www.adelaidenow.com.au/our-top-female-scientists-honoured/story-e6frea6u-1226119248204
- Science’s mystery – where are the women? www.adelaidenow.com.au/sciences-mystery-where-are-the-women/story-e6frea6u-1226098622349
- Three female engineers build toys to inspire young girls to love science venturebeat.com/2012/08/18/maykah-toys-for-girls/#03VwKaGRswxFauSo.99 <http://venturebeat.com/2012/08/18/maykah-toys-for-girls/>
- Women key to reversing SA skills shortage www.adelaidenow.com.au/business/sa-business-journal/women-key-to-reversing-skills-shortage/story-e6fredel-1226459017047

Movies with women scientists

Contact Dr Eleanor Arroway – A scientist who searches for extra-terrestrial intelligence

I, Robot Dr Susan Calvin– Chief robot-psychologist of US Robots and Mechanical Men

STEM Careers Pack 1: You Can be a Scientist is a publication of RiAus (Royal Institution of Australia) in partnership with DECD (Department for Education and Child Development).

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