Engaging students with science: Australian and Victorian perspectives

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Victorian Curriculum and Assessment Authority
Australia

Ruby, aged nearly 4: "This is a drawing of Elsa, from '*Frozen*' – but I can only draw her with straight hair!"

Victorian Early Years Learning and Development Framework (0-8 years of age): Ruby uses drawing to express ideas and make meaning

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Seminar aims

- ❑ Outline the basis for national curriculum design
- ❑ Explain the structure of the Australian Curriculum
- ❑ Discuss how the Victorian Curriculum embodies the Australian Curriculum
- ❑ Summarise national assessment
- ❑ Provide examples of how proactive, interactive, deep learning is enabled in:

  - secondary schools in Victoria, by examining the flexibility and autonomy in curriculum delivery

  - primary schools in Victoria, by looking at a case study

CONTEXT FOR DEVELOPMENT OF AN AUSTRALIAN CURRICULUM

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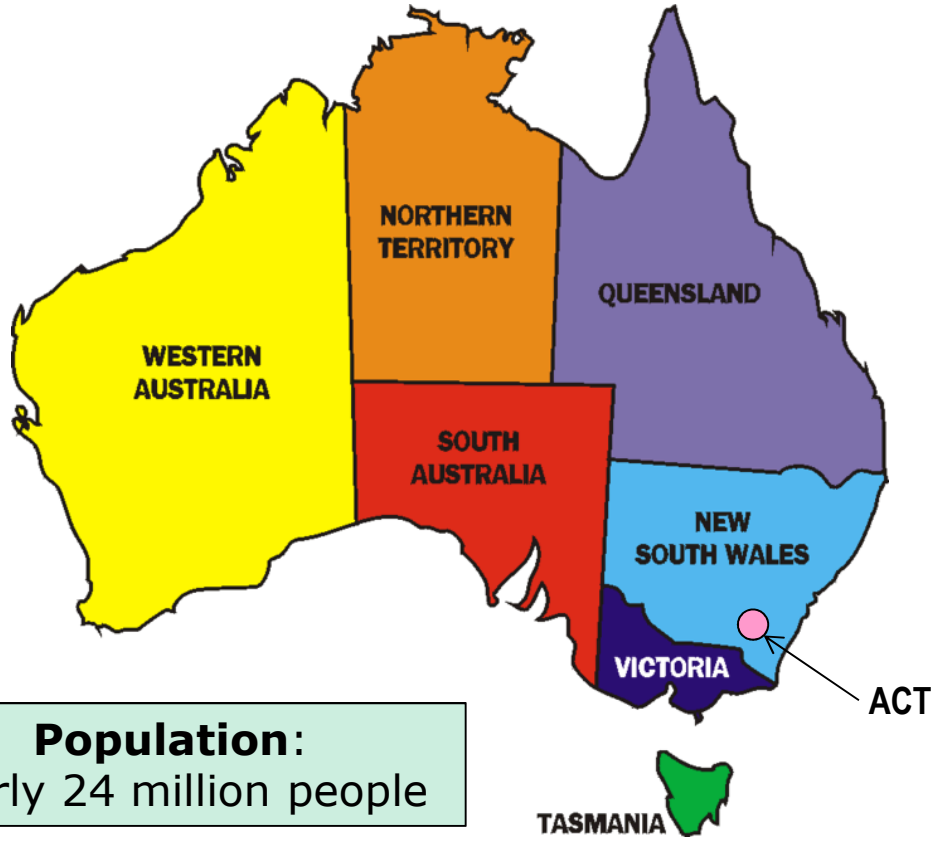
A collaborative approach

- Education is the responsibility of the six states and two territories of Australia
- Following the 'Melbourne Declaration' in 2008, states and territories agreed to work together to develop a national curriculum
- National curriculum frameworks were developed for early learning, primary, secondary and pre-tertiary levels of education



Population:
nearly 24 million people

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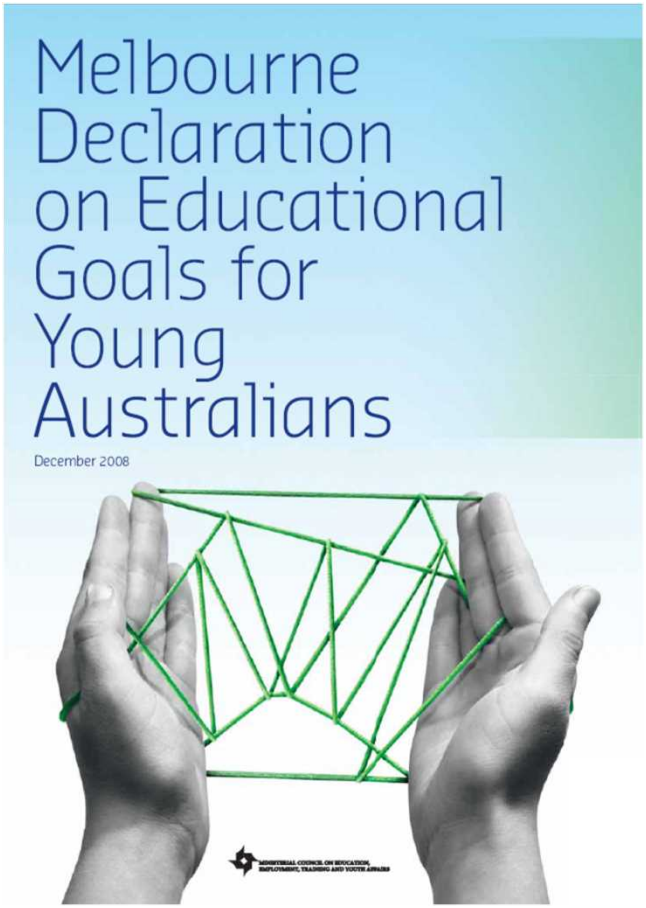
The basis for an Australian curriculum



http://www.curriculum.edu.au/verve/_resources/National_Declaration_on_the_Educational_Goals_for_Young_Australians.pdf

World-class curriculum and assessment:

- **a solid foundation in skills and knowledge for further learning**
- **deep knowledge and skills**
  - **→ advanced learning**
  - **→ ability to create new ideas**
- **general capabilities that underpin**
  - **→ flexible and critical thinking**
  - **→ capacity to work with others**
  - **→ ability to move across subject disciplines to develop new expertise.**

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Educational Goals for Young Australians

- Goal 1: Australian schooling promotes equity and excellence

- Goal 2: All young Australians become:
  - successful learners
  - confident and creative individuals
  - active and informed citizens

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TRANSLATING EDUCATIONAL GOALS INTO CURRICULUM AND ASSESSMENT

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Importance of early education

The Early Years Learning Framework was developed by the Council of Australian Governments to contribute to realising the vision that:

"All children have the best start in life to create a better future for themselves and for the nation."

http://files.acecqa.gov.au/files/National-Quality-Framework-Resources-Kit/belonging_being_and_becoming_the_early_years_learning_framework_for_australia.pdf

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Early Years Learning Framework: Belonging, Being and Becoming

Five main outcomes

Children:

- ❑ have a strong sense of identity
- ❑ are connected with and contribute to their world
- ❑ have a strong sense of wellbeing
- ❑ are confident and involved learners
- ❑ are effective communicators

Focus on play-based learning

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Australian Curriculum: Years Foundation to 10 (compulsory schooling)

http://www.australiancurriculum.edu.au/

Learning areas	General capabilities	Cross-curriculum priorities
English	Literacy	Aboriginal and Torres Strait Islander Histories and Cultures
Mathematics	Numeracy	
Science	Critical and Creative Thinking	
Humanities	Personal and Social Capability	Asia and Australia's Engagement with Asia
The Arts	Ethical Understanding	Sustainability
Technologies	Intercultural understanding	
Health and Physical Education	Information and Communication Technology	
Languages		
Optional: Work studies (Years 9 and 10)		

Australian Curriculum: Science

- **Development of the Australian Curriculum: Science was informed by the paper:**

‘Shape of the Australian Curriculum: Science’

https://acaraweb.blob.core.windows.net/resources/Australian_Curriculum_-_Science.pdf

- **Of particular interest to educators was the statement:**

“…there needs to be less emphasis on a transmission model of pedagogy and more emphasis on a model of student engagement and inquiry…”

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Science aims:

https://acaraweb.blob.core.windows.net/resources/Australian_Curriculum_-_Science.pdf

- The aim of the Australian science curriculum is to provide students with a solid foundation in science knowledge, understanding, skills and values on which further learning and adult life can be built
- In particular, *the science curriculum should foster an interest in science and a curiosity and willingness to speculate about and explore the world*. Students should be able to engage in communication of and about science, value evidence and scepticism, and question scientific claims made by others. They should be able to *identify and investigate scientific questions, draw evidence-based conclusions and make informed decisions about their own health and wellbeing*. Science is a human endeavour that students should learn to appreciate and *apply to daily life*.

Types of scientific inquiry: from 'transmission' to engagement

Level of inquiry	Problem or question	Procedure	Solution
Confirmation/ verification	Teacher	Teacher	Teacher
Structured	Teacher	Teacher	Student
Guided	Teacher	Student	Student
Coupled (linked to an earlier inquiry)	Initial: Teacher Coupled: Student	Student	Student
Open	Student	Student	Student

Senior Curriculum (Years 11 and 12)

http://www.australiancurriculum.edu.au/

15 subjects:

English	Mathematics	Science	Humanities
Essential English	Essential Mathematics	Biology	Ancient History
English	General Mathematics	Chemistry	Modern History
Literature	Mathematical Methods	Earth and Environmental Science	Geography
English as an Additional Language or Dialect	Specialist Mathematics		
		Physics	

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National Assessment Program

http://www.nap.edu.au/

National Assessment Program – Literacy and Numeracy (NAPLAN)

The main purposes of NAPLAN are:

- **enable governments, education authorities and schools to determine whether young Australians are meeting important educational goals in literacy and numeracy.**
- **To give parents information on how well their children are developing fundamental skills in literacy and numeracy**

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Other national assessments

http://www.nap.edu.au/nap-sample-assessments

Sample assessments on a three-yearly basis.

- **Science literacy (Year 6)**
- **Civics and citizenship (Years 6 and 10)**
- **Information and communication technology (ICT) literacy (Years 6 and 10).**

VICTORIAN CURRICULUM PERSPECTIVES

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Victorian education priorities

There is important **(including science-related)** content that every young Victorian should learn. This includes:

- Australia's system of government, history and cultures, including Aboriginal and Torres Strait Islander histories and cultures
- the values of democracy, equity and justice, including reconciliation between Indigenous and non-Indigenous Australians
- high levels of enabling skills in English **literacy** and **numeracy**
- a broad knowledge and understanding of **the importance of the STEM** (**Science**, Technology, Engineering and Mathematics), Humanities and Arts **disciplines**
- **the knowledge and skills necessary for participation in a digital world**
- knowledge of how wellbeing and safety can be protected and nurtured
- **attributes central to participation in the contemporary economy and for civic participation such as creativity and innovation, critical thinking, problem-solving, and learning to learn**

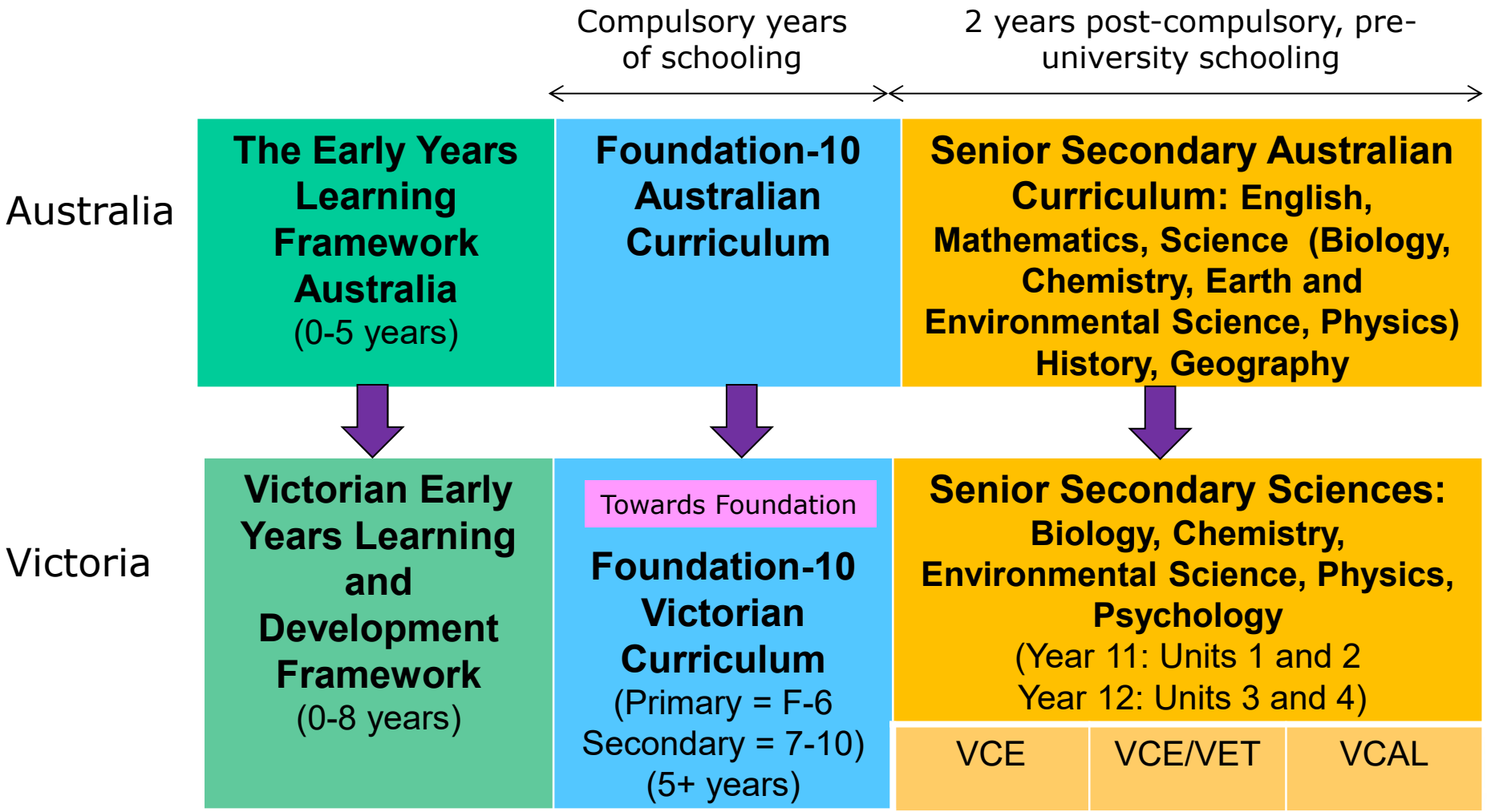
Education State Targets
Goal: Learning for life

More students –

- ✓ excel in reading and mathematics (NAPLAN)
- ✓ excel in scientific literacy (PISA)
- ✓ excel in the arts (Victorian Curriculum)
- ✓ develop strong critical and creative thinking skills (Victorian Curriculum online assessment)

Source: The Education State: Schools, 2015

Victorian Curriculum: building on the Australian Curriculum



Early Years Education

The Early Years Learning Framework Australia

(0-5 years)

Victorian Early Years Learning and Development Framework for all Children from Birth to Eight Years

http://www.education.vic.gov.au/childhood/providers/edcare/pages/veyladf.aspx?Redirect=1

FIGURE 1
Annette Sax (Taungurung) 2016

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Victorian curriculum - design and structure

http://victoriancurriculum.vcaa.vic.edu.au/

Learning areas	Capabilities
English	Critical and creative thinking
Mathematics	Personal and social capability
Science	Intercultural capability
Health and physical education	Ethical capability
Humanities and social sciences (*History*, *Geography*, *Civics and citizenship*; *Business and economics*)	
Languages	
The Arts	
Technologies (*Design and technologies* and *Digital technologies*)	

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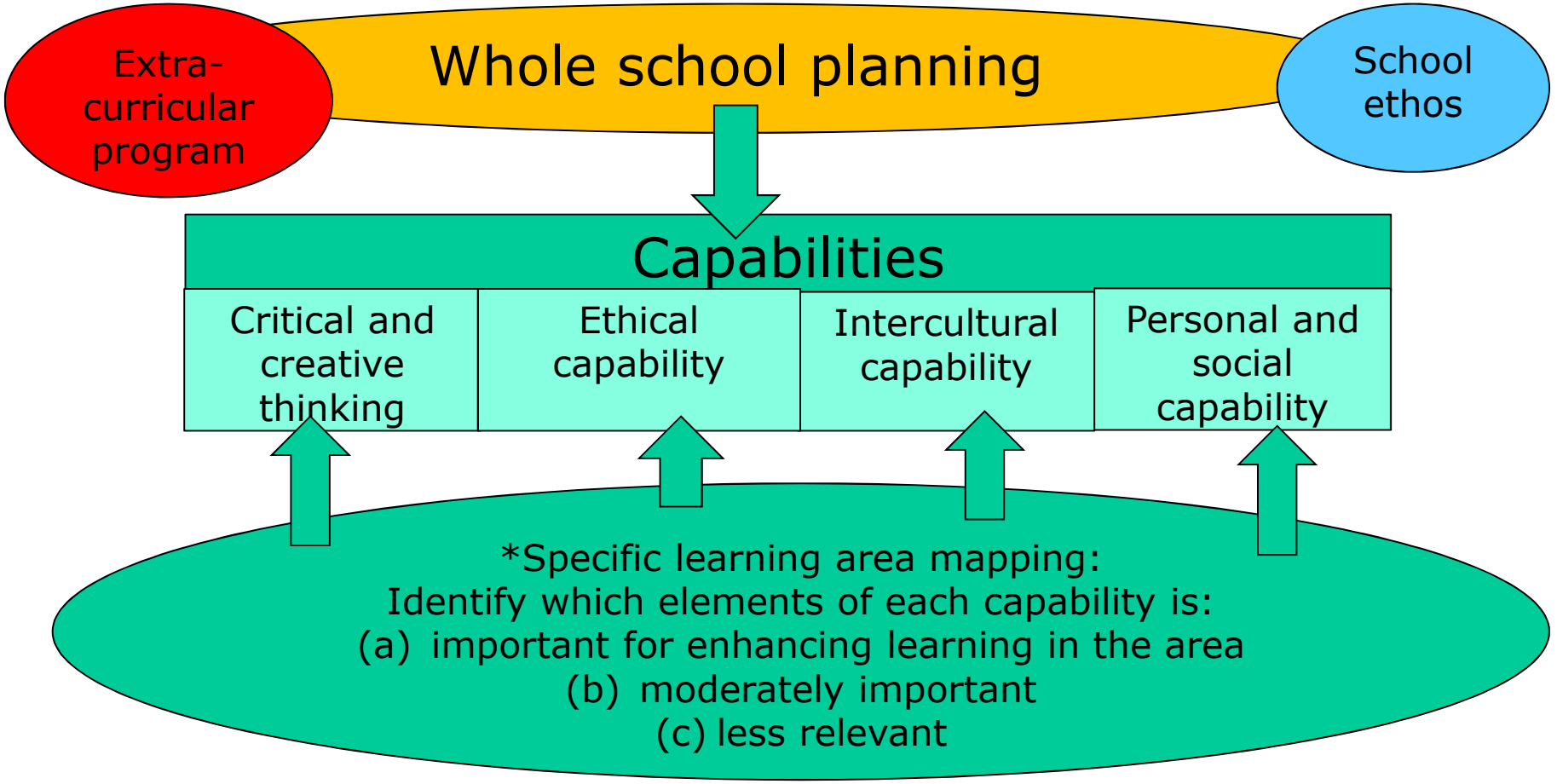
One approach to whole-school planning



*Note: mapping across all 8 learning areas should confirm coverage of all elements of the capabilities

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Science curriculum structure Years F-10

Australian Curriculum	
Strand	Sub-strand
Science Understanding	Biological sciences
	Chemical sciences
	Earth and space sciences
	Physical sciences
Science as a Human Endeavour	Nature and development of science
	Use and influence of science
Science Inquiry Skills	Questioning and predicting
	Planning and conducting
	Processing and analysing data and information
	Evaluating
	Communicating

Victorian Curriculum Science	
Strand	Sub-strand
Science Understanding	**Science as a human endeavour**
	Biological sciences
	Chemical sciences
	Earth and space sciences
	Physical sciences
Science Inquiry Skills	Questioning and predicting
	Planning and conducting
	Recording and processing
	Analysing and evaluating
	Communicating

Level Foundation–2
Construct a Minibeast Hotel

- **Identify and record life in the school ground**

- What do living things need to survive?
- What are life cycles and do all animals have the same life cycles?
- How might we attract wildlife to our school ground?

- **Choose and arrange materials and safe tool use**

- Do materials change over time?
- What makes materials 'safe'?

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Victorian Curriculum: Science

How does combining '*Science Understanding*' and '*Science as a Human Endeavour*' help teachers to personalise learning for their students?

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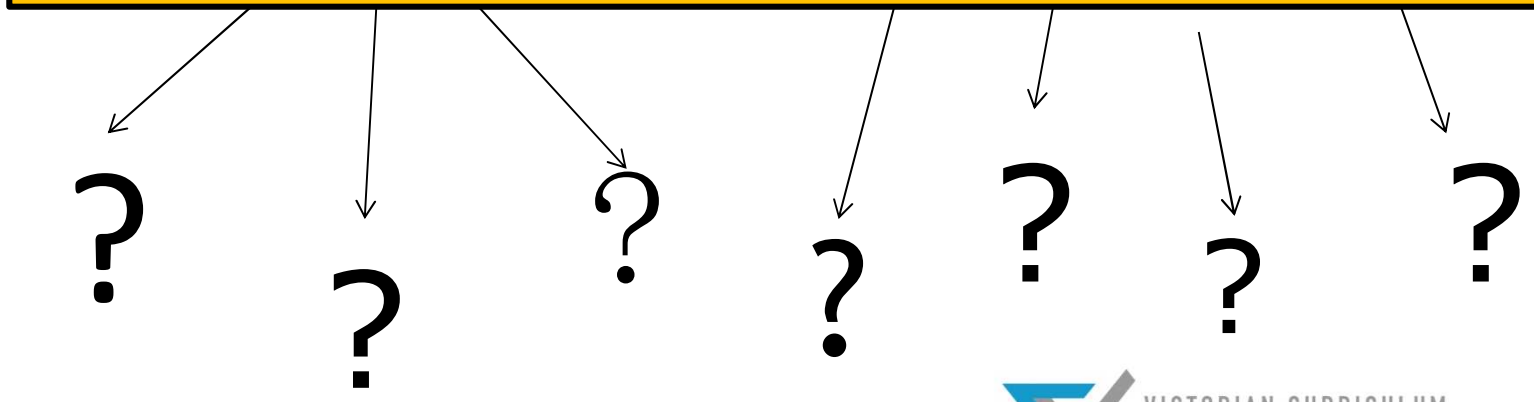
Cells: planning learning

What conceptual understandings and skills are involved in teaching the following content description?

***SU Levels 7&8*: Cells are the basic units of living things and have specialised structures and functions**



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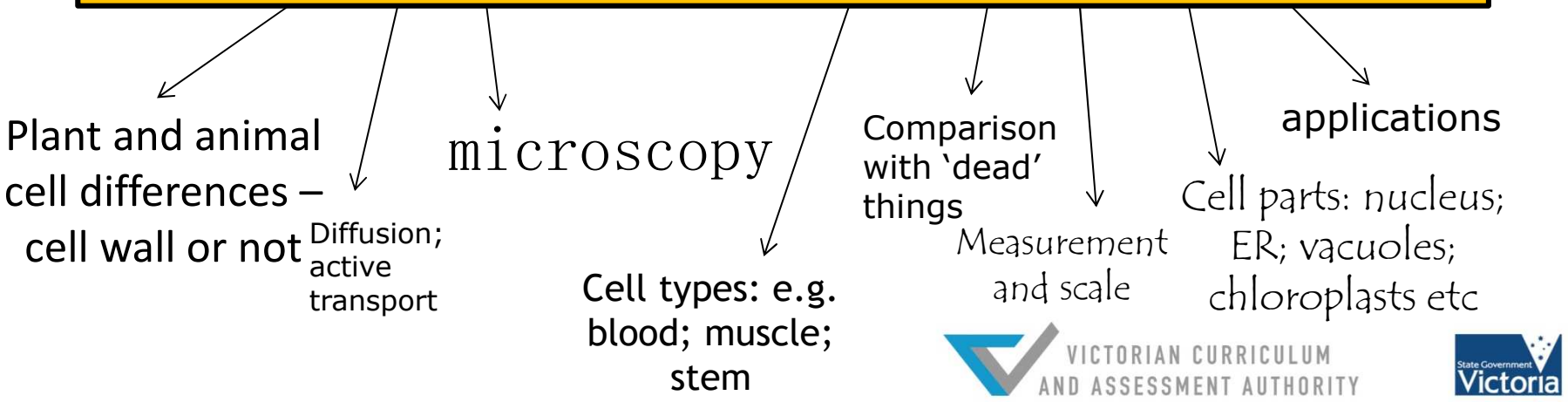
Why combine SHE and SU?

What conceptual understandings and skills are involved in teaching the following content description?

SU Levels 7&8: Cells are the basic units of living things and have specialised structures and functions



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Why combine SHE and SU?

SHE Years 7&8: Scientific knowledge and understanding of the world changes as new evidence becomes available

SHE Years 7&8: Science knowledge can develop through collaboration and connecting ideas across the disciplines and practice of science

***SU Years 7&8*: Cells are the basic units of living things and have specialised structures and functions**

SHE Years 7&8: Solutions to a range of contemporary issues can be found using science and technology but may impact on other areas of society and involve ethical considerations

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Why combine SHE and SU?

Content description:

SU Levels 7&8:

Cells are the basic units of living things and have specialised structures and functions

Add 'science as a human endeavour' content description:

SHE Levels 7&8:

Solutions to a range of contemporary issues can be found using science and technology but may impact on other areas of society and involve ethical considerations

Examples related to student interest and engagement:

- Cloning
- Cryogenics
- Reversal of cell aging
- GM foods
- Stem cell therapies
- Skin cancers

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Why combine SHE and SU?

Content description:

SU Levels 7&8:

Cells are the basic units of living things and have specialised structures and functions

Add 'science as a human endeavour' content description:

SHE Levels 7&8: Science knowledge can develop through collaboration and connecting ideas across the disciplines and practice of science

Examples related to student interest and engagement:

- Fiona Wood (a plastic surgeon) and Marie Stoner (medical scientist) - work on 'spray on skin' for burns victims
- Scientific collaborative groups such as Diabetes Research Institute Federation seeking to find diabetes cure
- Interdisciplinary knowledge needed to research bacterial resistance to antibiotics (identify roles of immunologists, biochemists, toxicologists, geneticists, statisticians, pharmacologists, cytologists)

Victorian Curriculum: Science

How do the capabilities and embedded cross-curriculum priorities engage students and deepen their understanding of science and its applications in the world around them?

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Exploring science language: primary years

Line	Template	Student example
1	What does the living thing start as?	egg
2	Size /shape /colour of (line 1 object)	brown-speckled, oval
3	Three things that (line 1 living thing) does (ending in “ing”) - description of where it does it and how it is done	resting, waiting, expecting – a twiggy nest protects
4	How does (line 1 object) change into (line 7) object?	breaking through a cracked shell into a new world…
5	Three things that (line 7 living thing) does (ending in “ing”) – description of where it does it and how it is done	stumbling, exploring, stretching – the fresh air welcomes
6	Size /shape /colour of (line 7 living thing)	fluffy, yellow
7	What does (line 1) become?	chicken

Literacy applications

Numeracy applications

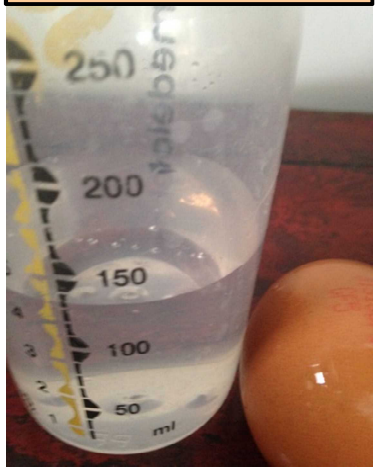
Eggs? Exactly!

How do class measurements of an egg's length and width compare?

Do eggs with larger circumferences crack more easily?

What is the degree of precision of different weighing machines?

Use Archimedes' principle to measure the volume of an egg



Does egg weight production by a single hen follow a normal distribution?

ICT applications

Are brown hens better egg layers than white hens?

Do brown eggs taste better than white eggs?

ICT can be used to generate, process and present scientific data and findings.

Both of these animals are endangered – which would you rather save?

A purple pig-nosed frog

Embedded sustainability concepts

A giant panda

Frogs and pandas – what should be our research priorities?

Years 9&10 Science	
Science Understanding: *Science as a Human Endeavour*	The values and needs of contemporary society can influence the focus of scientific research
Science Understanding: *Biological sciences*	Multicellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment
	Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems
Science Inquiry Skills: *Communicating*	Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations

‘Ugly’ frog or ‘cute’ panda?

Significant public funding and research is allocated to protecting and conserving species, for example the Giant panda. In 2014, there were 2464 animals with an assessment of “critically endangered” (compared with 1998 levels of 854). How are species selected as targets for conservation?

Activities:

- **Critical thinking: discuss cases where species have been supported by public funding and/or research and consider, “How does being ‘cute’ or ‘ugly’ affect the survival chances of a species?”**
- **Creative thinking: select an ‘ugly’ threatened animal and prepare an advertising campaign (TV advertisement; poster; pamphlet) to promote the case for its conservation.**

Medicine and fuel – at what cost?

A species of Himalayan yew tree, *Taxus contorta*, is used to produce Taxol, a chemotherapy drug used to treat human cancers. It is also used for fuel. The tree is now reported to be on the brink of extinction.

- **Critical thinking:** Should yew trees be harvested for medicine or fuel?
- **Creative thinking:** Develop and assess alternate strategies for ensuring renewability of the Himalayan yew tree

Victorian Curriculum: Science

How can teaching science within an interdisciplinary context be used to engage students?

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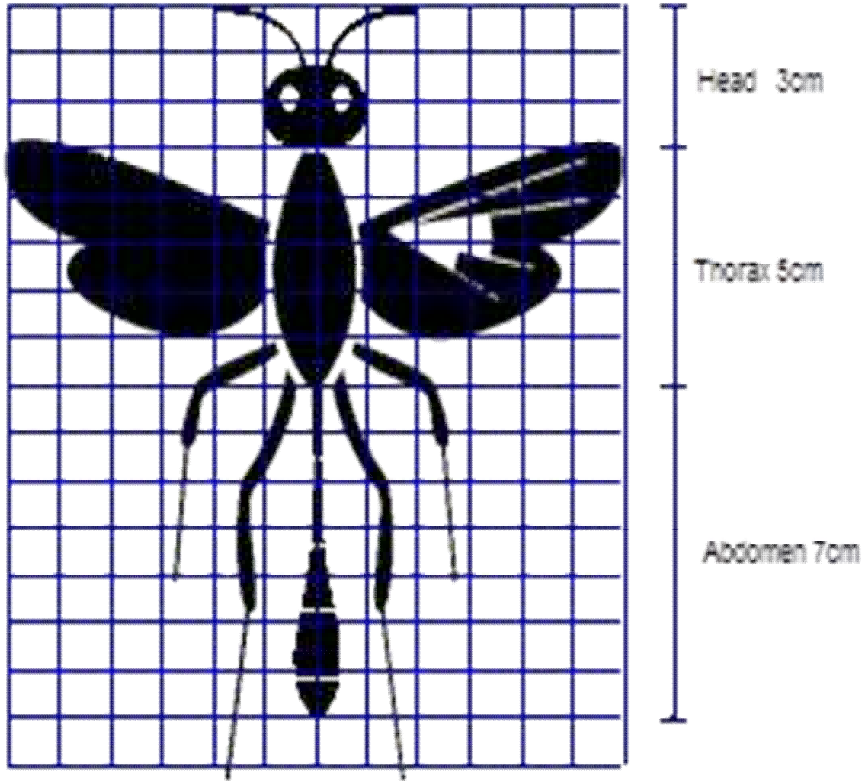
Secondary school example:
Science links to Mathematics

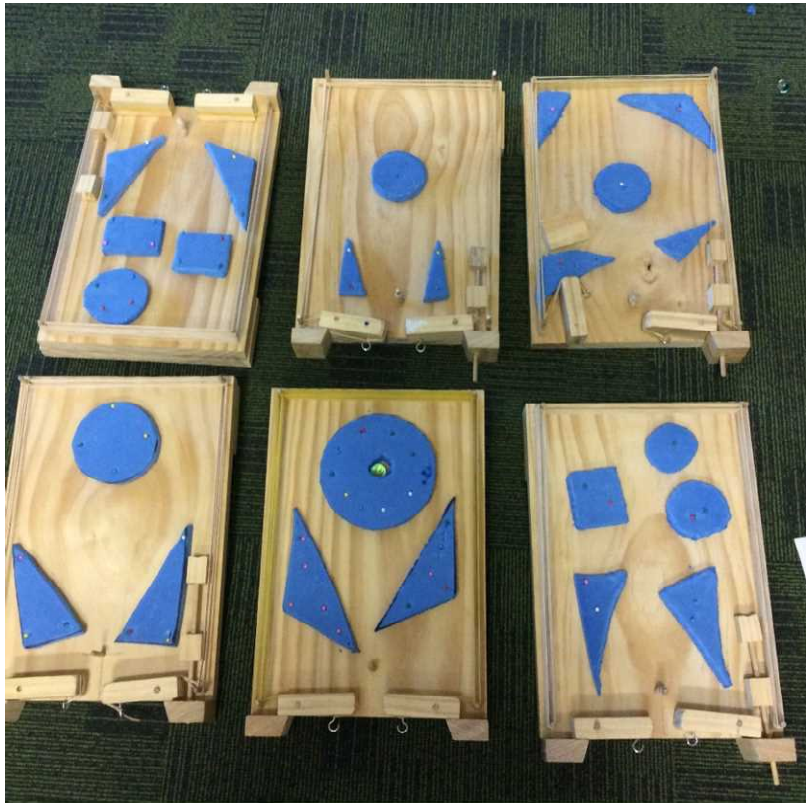
Is this a new insect?



STEM: Pinball machines

- **Science**
  - Forces
- **Mathematics**
  - Properties of circles
  - Angles
- **Design and Technologies**

  Creating Designed Solutions
  - Investigating, generating, planning and managing, producing, evaluating



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Cross-peer learning: science links to music

Levels F-2 Science: Light and sound are produced by a range of sources and can be sensed

Class concert

Set of student-constructed string instruments

Levels 7&8 Science: The properties of sound can be explained by a wave model

Levels 1&2 Music: Sing and play instruments to improvise, compose and practise a repertoire of chants, songs and rhymes, including those used by cultural groups in the local community

The music of chemistry

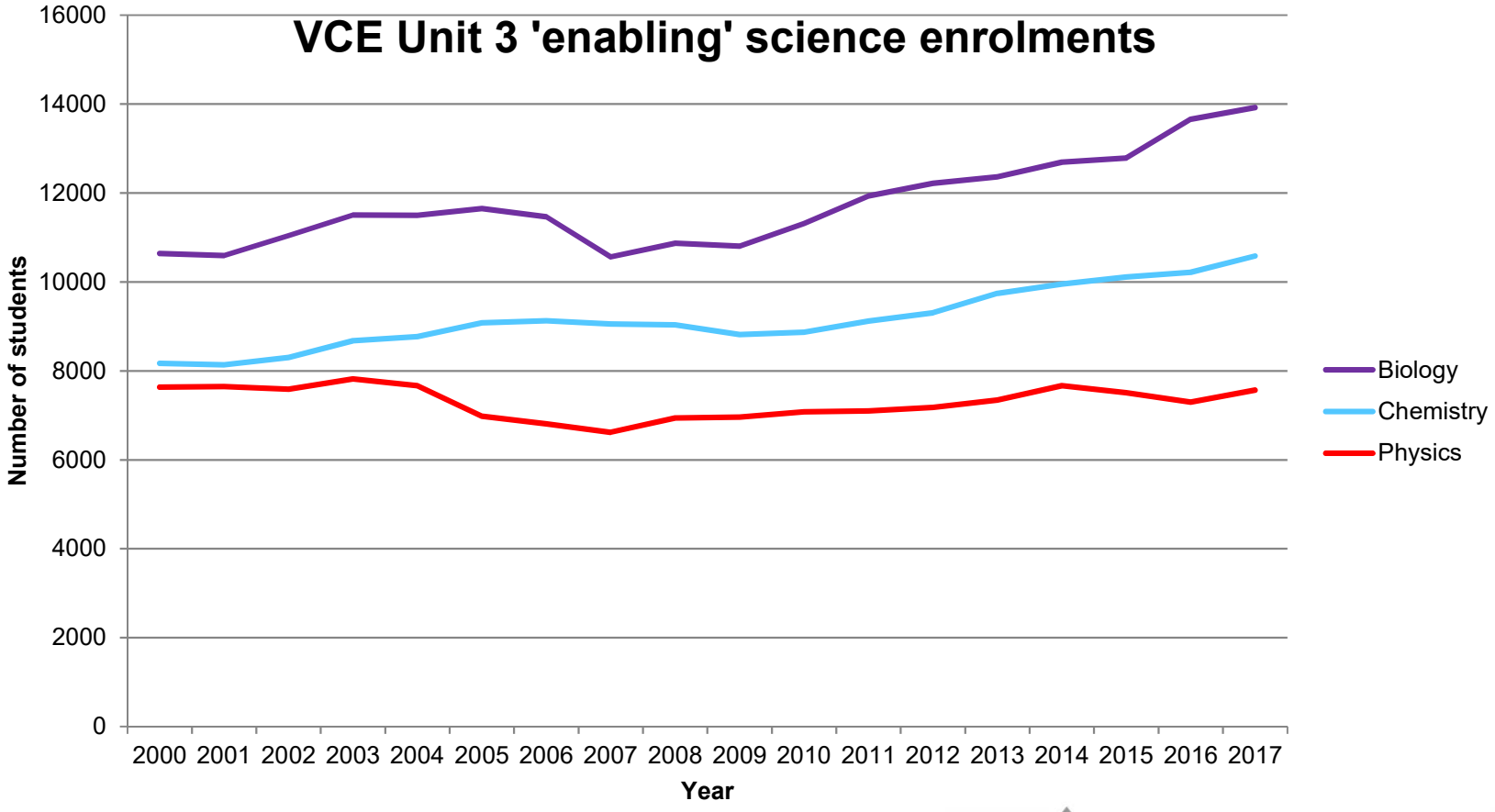
Visible evidence of a chemical reaction: colour change; production of a gas
Other sensory observations: energy change; odour production

Task: Students take time-lapse images of a chemical reaction involving visible changes and present a slow-motion sequence of the chemical change, accompanied by selected music that focuses on important aspects of the change

Science skills F-12 continuum

Victorian Curriculum Science Inquiry Skills	VCE key science skills
Questioning and predicting	Develop aims and questions, formulate hypotheses and make predictions
Planning and conducting	• Plan and undertake investigations • Comply with safety and ethical guidelines • **Conduct investigations** to collect and record data
Recording and processing	Conduct investigations to **collect and record data**
Analysing and evaluating	• Analyse and evaluate data, methods and scientific models • Draw evidence-based conclusions
Communicating	Communicate and explain scientific ideas

Pre-university Victorian senior secondary science enrolments 2000-2017



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Sample Units 3 and 4 inquiry questions from students

- **Biology:** Is there a better way to measure the rate of photosynthesis?
- **Chemistry:** Which factors affect the amount of metal deposited at a cathode in the electrolysis of an ionic compound?
- **Environmental Science:** How does temperature inversion affect the accumulation of pollutants?
- **Physics:** Does the height of a leap depend on the depth of a squat from a standing start?
- **Psychology:** What effect does concurrently listening to music have on the time taken to complete a task?

CASE STUDY:

The Patch Primary School

Dandenong Ranges, Victoria

280 students, 30 staff

Creating a 'learning landscape'

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What is the problem?

There is an area of the school that nobody uses.

Students in Grades 5 and 6 were given a broad 'design brief' to propose a solution to this problem.

A 'learning landscape' was negotiated as a multi-functional school community space

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Preferred Landscape Elements

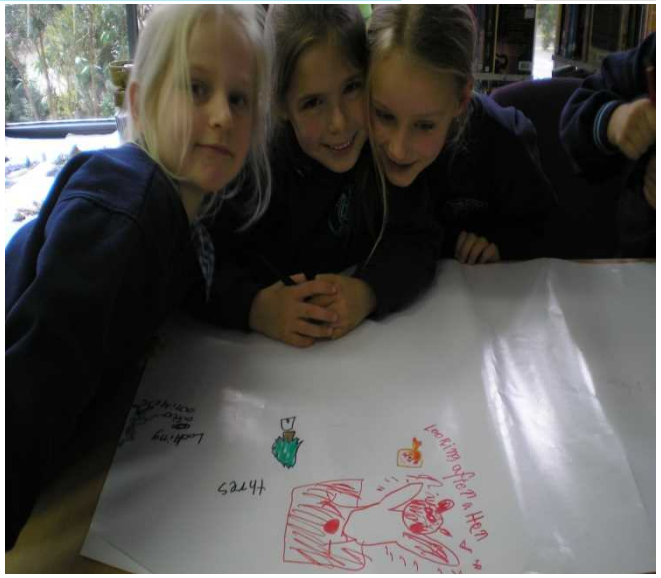
Top 10 elements identified by students for inclusion in 'learning landscape' design

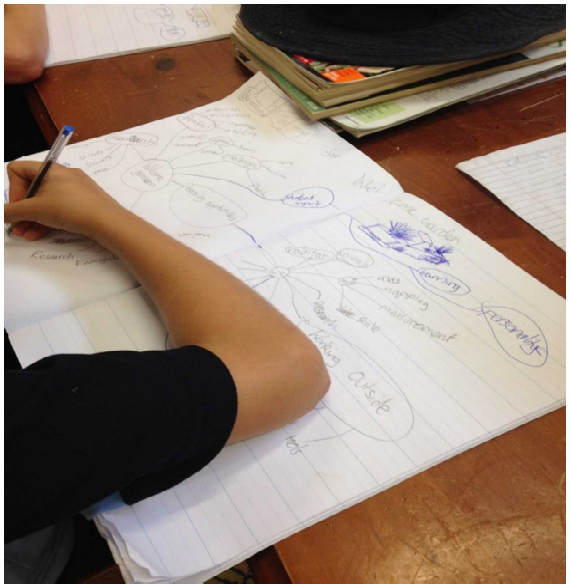
- Water
- Animals
- Construction Opportunities
- Maze
- Meeting Place and Performance Area
- Pizza Garden and Pizza Oven
- Artwork and Sculpture
- Secluded Spaces and Seating
- Edible Plants and Flowers
- Area to Climb and Play

Learning opportunities

Identify what the students want to learn about

Establish how student interests will align to curriculum elements





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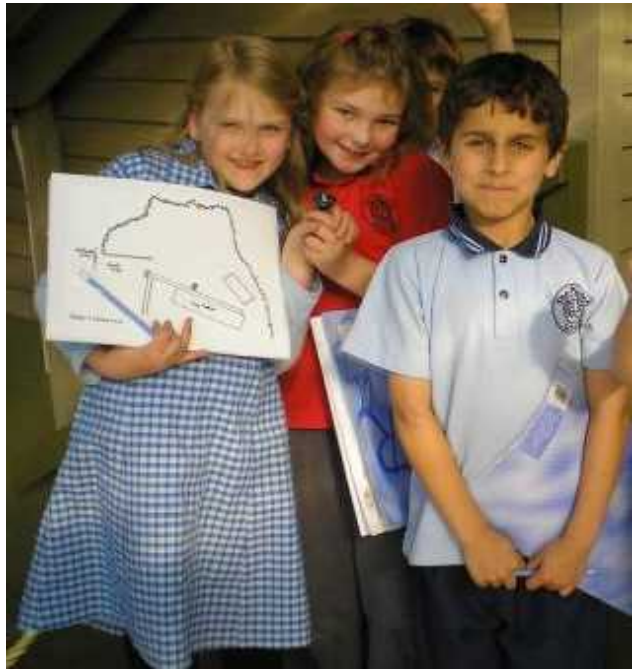
Conduct Site Surveys:
physical features

- Slope
- Soil type
- Soil pH
- Water content
- Orientation

Conduct site surveys:
living things

Animal and vegetation surveys



Collate data

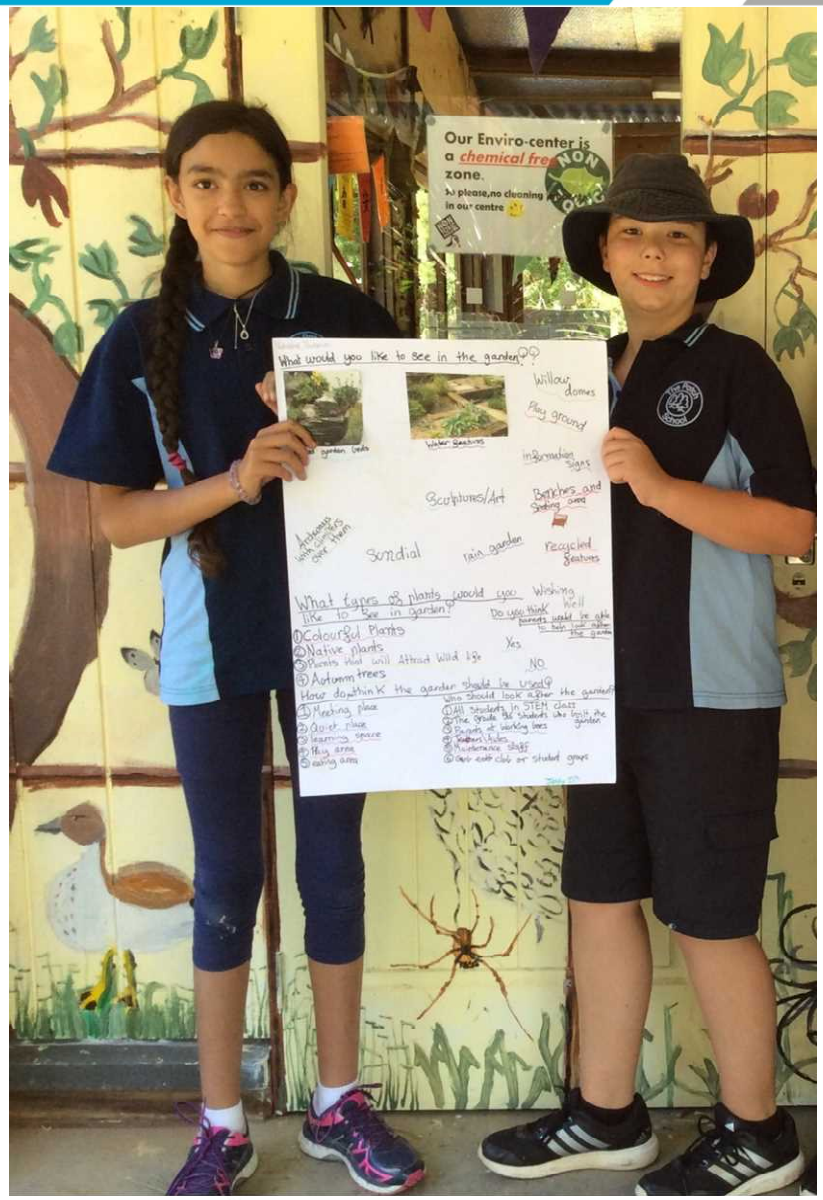
Analyse results and their implications for the site

Consult with the community

Gather feedback to identify broader views and to share ownership

Summarise community recommendations

Negotiate suitable procedures for resolving issues and evaluating alternative views



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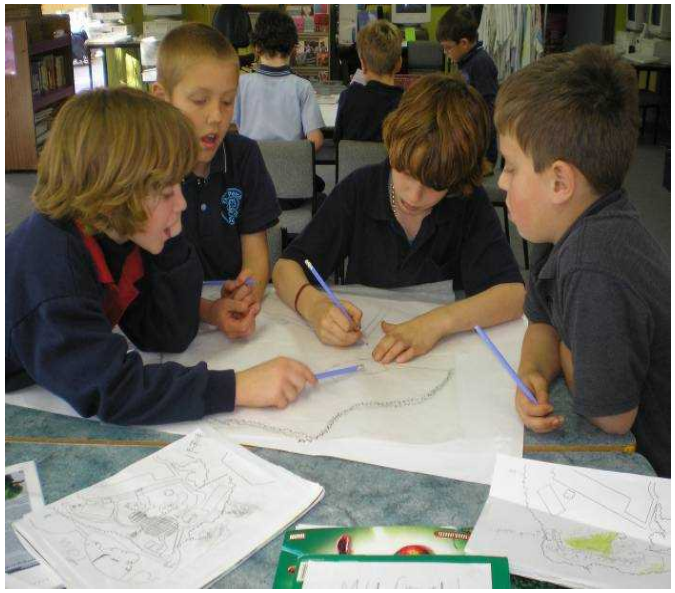

Develop a concept for the garden design

Individual and group ideas and drawings

Research and discussion

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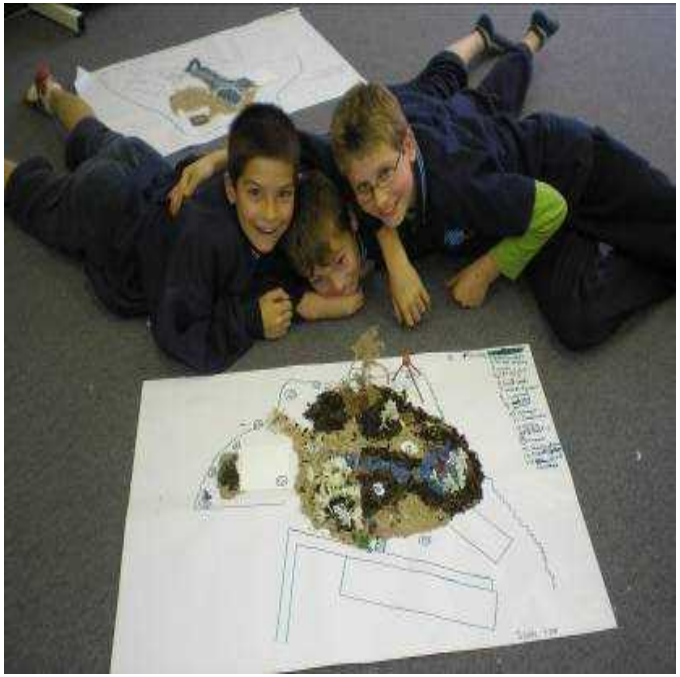
Model Designs

Identifying garden elements

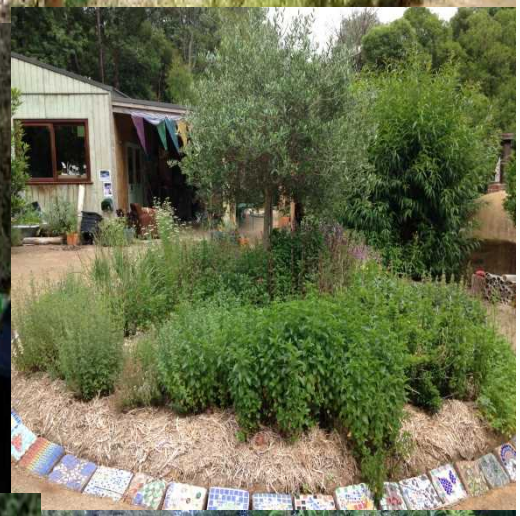


Final Concept Plan

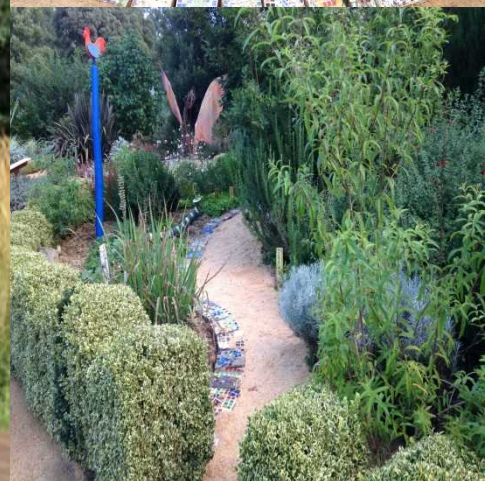
The Patch School "Learning Landscape" 2016









ご清聴ありがとうございました。

Thank you very much for your attention

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