Designing a STEM unit

Teaching, learning and assessment advice

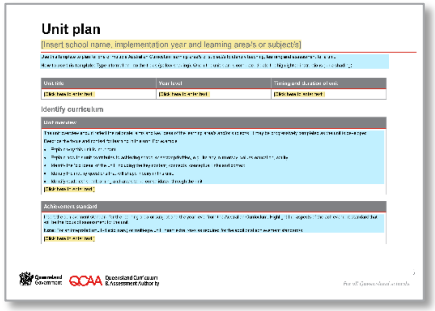
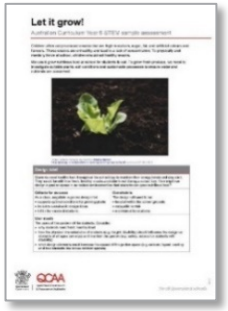
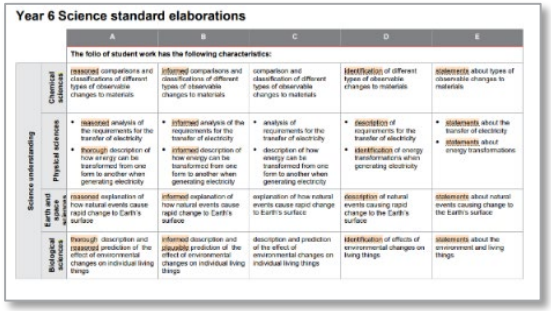
A STEM approach to teaching and learning provides opportunities for students to develop knowledge, understanding and skills across Science, Technologies, Engineering and Mathematics.

How teachers use this advice

Teachers can use this advice when planning for the teaching, learning and assessment of a purposefully integrated STEM unit. The advice uses a QCAA sample STEM unit plan and assessment, and standards elaborations to show how teaching, learning and assessment can be integrated.

The sample STEM unit plan is based on the QCAA unit plan template, which supports teachers to plan for an integrated STEM unit and incorporates the six interdependent elements for effective planning contained in the QCAA advice *Planning for teaching, learning and assessment*: www.qcaa.qld.edu.au/downloads/aciq/general-resources/teaching/ac_plan_teach_learn_assess.pdf.

Access the QCAA resources

Unit plan template	Sample unit plan and assessment	Standards elaborations (SEs)
		
The sample STEM unit plan is based on the QCAA unit plan template: www.qcaa.qld.edu.au/downloads/aciq/general-resources/teaching/ac_unit_plan_template.dotx.	The sample STEM unit plan and assessment *Let it grow!* integrate the curriculum across learning areas: www.qcaa.qld.edu.au/p-10/aciq/frequently-used-resources/stem.	The sample STEM unit plan and assessment *Let it grow!* draws from the Year 6 Science and the Years 5 and 6 band Design and Technologies SEs: www.qcaa.qld.edu.au/p-10/aciq/standards-elaborations.

Stage 1: Identify curriculum

Determine the conceptual link

The foundation for a purposefully integrated STEM unit is an authentic conceptual link between learning areas and/or subjects. It encapsulates the rationale of the unit and is often drawn from an engaging real-world context.

The conceptual link in the sample STEM unit addresses the problem of unhealthy eating throughout the school day. In:

- Science, students investigate optimal conditions for growing plants
- the Design and Technologies context of Food and Fibre Production and Food Specialisation, students apply their scientific understanding to design a sustainable garden that will provide the community with nutritious food.

Access resources to support your development

- sample STEM unit plan — *Let it grow!*
- Australian Curriculum
- QCAA unit plan template

Identify the evidence of learning to be collected in the unit

The key elements of the Australian Curriculum **achievement standard** for Science and Design and Technologies are shaded blue.

The **cognitive verbs** (thinking required) are shaded orange.

These highlighted elements inform the evidence of learning to be collected in the integrated unit.

Achievement standard

Science

By the end of Year 6, students compare and classify different types of observable changes to materials. They analyse requirements for the transfer of electricity and describe how energy can be transformed from one form to another when generating electricity. They explain how natural events cause rapid change to Earth's surface. They describe and predict the effect of environmental changes on individual living things. Students explain how scientific knowledge helps us to solve problems and inform decisions and identify historical and cultural contributions.

Students follow procedures to develop investigable questions and design investigations into simple cause-and-effect relationships. They identify variables to be changed and measured and describe potential safety risks when planning methods. They collect, organise and interpret their data, identifying where improvements to their methods or research could improve the data. They describe and analyse relationships in data using appropriate representations and construct multimodal texts to communicate ideas, methods and findings.

Design and Technologies

By the end of Year 6, students describe competing considerations in the design of products, services and environments, taking into account sustainability. They describe how design and technologies contribute to meeting present and future needs. Students explain how the features of technologies impact on designed solutions for each of the prescribed technologies contexts.

Students create designed solutions for each of the prescribed technologies contexts suitable for identified needs or opportunities. They suggest criteria for success, including sustainability considerations, and use these to evaluate their ideas and designed solutions. They combine design ideas and communicate these to audiences using graphical representation techniques and technical terms. Students record project plans including production processes. They select and use appropriate technologies and techniques correctly and safely to produce designed solutions.

Select the relevant content descriptions

The relevant Australian Curriculum **content descriptions** describe what is to be taught throughout the integrated unit and what students will learn. The sample assessment *Let it grow!* draws from Year 6 Science and the Years 5 and 6 band of Design and Technologies.

Although the Science **inquiry skills** are not highlighted on the achievement standard, they will be a part of the teaching and learning in this unit with the expectation that they will be assessed in a future unit.

Content descriptions	
Science understanding	**Science inquiry skills**
Biological sciences: The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)	**Questioning and predicting:** With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS232) **Planning and conducting:** Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks (ACSIS103) Decide variables to be changed and measured in fair tests, and observe, measure and record data with accuracy using digital technologies as appropriate (ACSIS104) **Processing and analysing data and information:** Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate (ACSIS107) Compare data with predictions and use as evidence in developing explanations (ACSIS221) **Evaluating:** Reflect on and suggest improvements to scientific investigations (ACSIS108)
Design and Technologies knowledge and understanding	**Processes and production skills**
Food and fibre production / Food specialisation: Investigate how and why food and fibre are produced in managed environments and prepared to enable people to grow and be healthy (ACTDEK021)	**Investigating and defining:** Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions (ACTDEP024) **Generating and designing:** Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques (ACTDEP025) **Producing and implementing:** Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions (ACTDEP026) **Evaluating:** Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions (ACTDEP027) **Collaborating and managing:** Develop project plans that include consideration of resources when making designed solutions individually and collaboratively (ACTDEP028)

Consider the general capabilities and cross-curriculum priorities

The Australian Curriculum **general capability** of critical and creative thinking naturally aligns with the context of this unit, specifically to the design of a solution. Providing opportunities for students to develop this general capability will add rigour to the learning in the unit.

Additionally, the **cross-curriculum priority** of sustainability can be embedded in both Science and Design and Technologies.

General capabilities	
Critical and creative thinking	Organise and process information — analyse, condense and combine relevant information from multiple sources Seek solutions and put ideas into action — assess and test options to identify the most effective solution to put ideas into action Reflect on processes — identify and justify the thinking behind choices they have made

Cross curriculum priorities	
Sustainability	Systems — All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival

Stage 2: Develop assessment

Identify the problem and problem-solving skills

For a STEM assessment, more than one learning area or subject can be incorporated into a task. The *Let it grow!* sample STEM assessment addresses the real-world problem of children eating processed snacks, which can lead to a lack in concentration throughout the school day.

The problem will be solved using the Design and Technologies processes and production skills to design a garden space in the school environment where students can grow nutritious food.

In developing assessment, ensure you have defined the task clearly so that students have clear boundaries for responding.

Access resources to support your development

- sample STEM assessment — *Let it grow!*
- Australian Curriculum

Prepare the assessment design brief

The **design brief** outlines the context of the problem; the parameters of the task, including constraints; and the desired outcome of the designed solution, i.e. a garden space.

The **criteria for success** include 'supports optimal conditions for growing plants'. This gives students the opportunity to apply **Biological science understanding** to the garden design.

Design brief

Students need healthy food throughout the school day to maintain their energy levels and stay alert.
They would benefit from fresh, healthy snacks available to eat during a school day. How might we design a garden space in our school environment so that students can grow nutritious food?

Criteria for success

As a class, negotiate a garden design that:

- supports optimal conditions for growing plants
- includes sustainable design ideas
- fulfils the needs of students.

Constraints

The design will need to be:

- located within the school grounds
- enjoyable to visit
- maintained by students.

User needs

The users of the garden will be students. Consider:

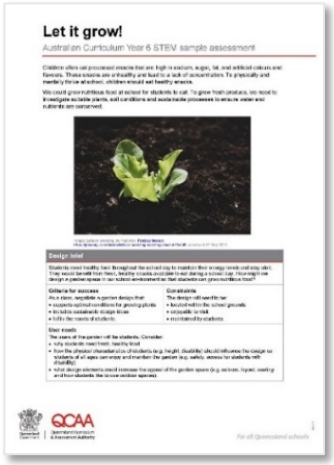
- why students need fresh, healthy food
- how the physical characteristics of students (e.g. height, disability) should influence the design so students of all ages can enjoy and maintain the garden (e.g. safety, access for students with disability)
- what design elements could increase the appeal of the garden space (e.g. colours, layout, seating and how students like to use outdoor spaces).

Develop materials for the assessment technique

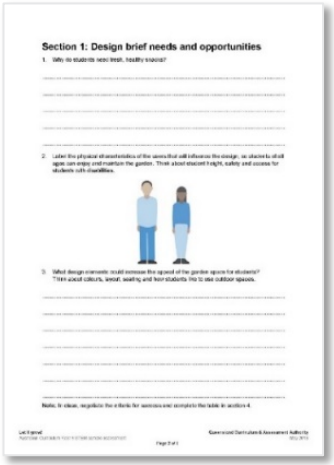
The assessment technique used in the *Let it grow!* sample STEM assessment is a **project**.

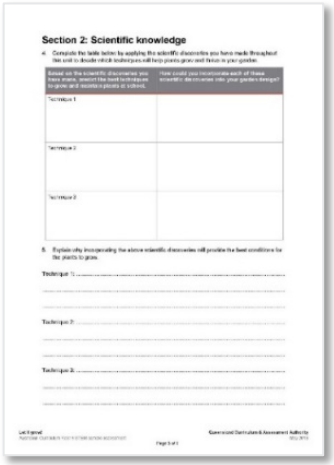
The assessment requires students to apply **Science knowledge** to designing a solution.

Students record their responses in a booklet.

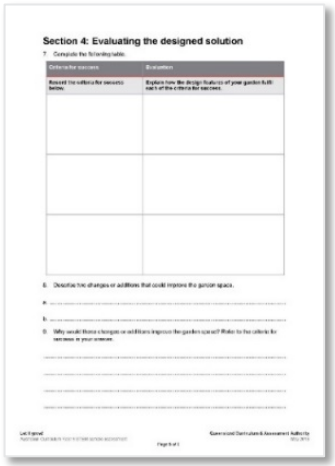

Let it grow!

Australian Curriculum Year 6 STEM sample assessment


Section 1: Design brief needs and opportunities


Section 2: Scientific knowledge


Section 3: Graphical representation


Section 4: Evaluating the designed solution

Stage 3: Plan teaching and learning

Identify and sequence the teaching and learning

In an integrated STEM unit, teachers select and sequence learning experiences and teaching strategies to support students to develop knowledge, understanding and skills in each learning area or subject.

Access resources to support your development

- sample STEM unit plan — *Let it grow!*
- Australian Curriculum
- QCAA unit plan template

Create teaching and learning plan

In the **Sequence teaching and learning** section of the unit plan, **the Learning intentions and success criteria** contain each of the identified **content descriptions** for each subject.

Some lessons focus on one subject while others purposefully combine both Science and Design and Technologies.

Real-world applications are purposefully incorporated in the planning for the sample STEM unit. Some examples include:

- excursion to a community garden
- experiments
- evaluation of the school's sustainability practices
- student surveys
- guest speakers.

Learning intentions and success criteria	Key teaching and learning experiences, including opportunities for feedback	Adjustments	Resources
Lessons 5–6 We are learning to investigate and evaluate sustainable techniques for improving soil. (ACTDEK021) (ACTDEP027) What I'm looking for is an understanding of the benefits of sustainable fertilising techniques such as composting. I'm also looking for an understanding of the need for sustainable water usage and systems that can enable this to happen in the school environment. This is because we need to be aware of our impact on the environment and include sustainable elements in our garden design.	• View 'Introduction "Technology" in Agribusiness' (see resource). • View 'The life in dirt' video (see resource) to explore the benefits of nutrient-rich soil conditions on the growth of plants. • Research the types of items that can and can't be placed in a compost bin (see 'Guide to composting and worm farms' resource). • Develop (as a class) composting 'criteria for success' and evaluate the composting that occurs at the school against the 'criteria for success'. • Consider the importance of water in the growth and maintenance of a plant. Discuss the importance of water conservation and evaluate how water is used throughout the school. As a class, brainstorm ways that water could be conserved. • Exit ticket activity: 1. Describe two benefits of composting. 2. Describe a technique that could be used to save water at home or at school.	Provide key points from the video and guide students to highlight important concepts as the movie progresses. Scaffold the 'criteria for success' with a visual thinking tool such as a web map (the evaluation can be located in the related circles).	• Introduction 'Technology' in AgriBusiness (2:23), www.youtube.com/watch?v=kIMGdeEhlIQ • ABC Education, 'The life in dirt' (5:19), http://education.abc.net.au/home#!/media/104056/soil-healthy-dirt-makes-healthy-plants • *City of Ipswich*, 'Guide to composting and worm farms', www.ipswich.qld.gov.au/__data/assets/pdf_file/0006/98205/Worm-Farm-Guide.pdf • *Global Education*, 'Web map', www.globaleducation.edu.au/verve/_resources/webmap.pdf

Lessons 7–8 rely on the regular, ongoing collection of scientific data from the beginning of the unit. This data is then used to develop **Science understanding** and **Science inquiry skills**.

Although the Science inquiry skills are not assessed in this unit, there is opportunity for students to develop these skills.

Learning intentions and success criteria	Key teaching and learning experiences, including opportunities for feedback	Adjustments	Resources
Lessons 7–8 We are learning to inquire into the impact of different variables on the growth of plants. (ACSSU094) (ACSIS232) (ACSIS103) (ACSIS104) (ACSIS107) (ACSIS221) (ACSIS108) What I'm looking for is a scientific inquiry where one variable is changed to measure the impact of that variable on the growth of a plant. This is because it is important to collect scientific evidence to support the design choices we are making so we can optimise the growing conditions in our designed garden space.	**Note:** It is suggested that these scientific investigations are started at the beginning of the unit. • Conduct a variety of scientific inquiries using seedlings. These will be monitored regularly over a two-week period and data will be collated and evaluated. – Possible experiments include an inquiry into the same type of plant growing ▪ in shade and in sunlight ▪ in a variety of soil types ▪ with a variety of watering conditions. • Write up an investigation as a science report. • Summarise the findings of the investigations in an infographic. • Opportunity to collect evidence of Science inquiry skills and provide feedback.	Use assistive technology where necessary and/or appropriate. Complete in pairs and/or groups.	• *ABC Education*, 'Plant lab', http://education.abc.net.au/home#!/media/1388685/plant-lab • *ABC Education*, 'Science experiment: Tasty sandwich sprouts', http://education.abc.net.au/newsandarticles/blog/-/b/2397251/science-experiment-tasty-sandwich-sprouts

Stage 4: Make judgments

Create a task-specific marking guide

The standards elaborations (SEs) use the Australian Curriculum achievement standards to provide teachers with a tool for making consistent and comparable judgments about how well, on a five-point scale, students have demonstrated what they know, understand and can do.

In a STEM assessment, more than one learning area or subject can be incorporated into a task. The task-specific standards (marking guide) reflect this by incorporating multiple learning areas or subjects.

Access resources to support your development

- sample STEM unit plan — *Let it grow!*
- QCAA unit plan template
- Year 6 Science and Years 5 and 6 band Design and Technologies standards elaborations (SEs)

Select the aspects of the SEs

The sample STEM assessment *Let it grow!* draws from the Year 6 Science and Years 5 and 6 band Design and Technologies SEs.

The rows of the SEs corresponding to the identified aspects of Science and Design and Technologies are selected and combined in a single document.

Rows that contain aspects of the achievement standard that are not being assessed are deleted.

The collection of evidence will reflect Science understanding as applied in Design and Technologies towards a designed solution. Therefore, a row with Biological sciences understanding is located above the Design and Technologies rows to reflect this.

			A	B	C	D	E
			The folio of student work has the following characteristics:				
Science	**Understanding**	**Biological sciences**	application of science knowledge to generate reasoned predictions and comprehensive solutions for growing and maintaining plants in our local area	application of science knowledge to generate predictions and informed solutions for growing and maintaining plants in our local area	application of science knowledge to generate predictions and solutions for growing and maintaining plants in our local area	application of science knowledge to generate predictions and partial solutions for growing and maintaining plants in our local area	recall of science facts
Design and Technologies	**Knowledge and understanding**	**Food and fibre production/ Food specialisation**	comprehensive explanation of how gardening techniques have informed the designed solution (a garden to grow healthy food)	detailed explanation of how gardening techniques have informed the designed solution (a garden to grow healthy food)	explanation of how gardening techniques have informed the designed solution (a garden to grow healthy food)	partial explanation of how sustainable gardening techniques have informed the designed solution (a garden to grow healthy food)	statements about features of the designed solution
	Processes and production skills	**Investigating and defining**	identification and explanation of student needs for growing healthy food within the school environment	identification and description of student needs for growing healthy food within the school environment	identification of student needs for growing healthy food within the school environment	identification of aspects of needs for growing healthy food	statements about needs or for growing healthy food
		Generating and designing	considered combination of design ideas, and comprehensive and effective communication of design ideas, to audiences using: • graphical representation techniques • technical terms	informed combination of design ideas and effective communication of design ideas to audiences using: • graphical representation techniques • technical terms	combination of design ideas and communication of these design ideas to audiences using: • graphical representation techniques • technical terms	partial combination of design ideas and partial communication of design ideas to audiences using aspects of: • graphical representation techniques • technical terms	fragmented combination of design ideas and fragmented communication of design ideas to audiences using aspects of: • representation techniques • everyday language
		Evaluating	considered evaluation of ideas and designed solutions using the suggested criteria for success, including sustainability considerations and improvements	informed evaluation of ideas and designed solutions using the suggested criteria for success, including sustainability considerations and improvements	evaluation of ideas and designed solutions using the suggested criteria for success, including sustainability considerations	explanation of ideas and designed solutions using the suggested criteria for success, including aspects of sustainability considerations	statements about their ideas and designed solutions using their suggested criteria for success