STEM and the Australian Curriculum: E is for engineering

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Senior Project Officer, Technologies

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Overview

• Overview of Australian Curriculum: science, technologies and mathematics
• Key ideas
• Engineering principles and systems
• Implementation and resources
Australian Curriculum: Science
Science curriculum

Curriculum has been developed:
• from Foundation to Year 10
• from Years 11 to 12 in four subjects: biology; chemistry; Earth and environmental science, and physics
Science: Organisation

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
Overarching ideas

• Patterns, order and organisation
• Form and function
• Stability and change
• Scale and measurement
• Matter and energy
• Systems

www.australiancurriculum.edu.au/Science/The-overarching-ideas
Key messages

The science curriculum…

– emphasises an inquiry approach
– has been written to encourage integration of the three strands
– utilises six overarching ideas to provide a conceptual frame for learning across F-10
– integrates the cross-curriculum priorities and the general capabilities
Australian Curriculum: Technologies
Technologies curriculum

Curriculum has been developed:
• from Foundation to Year 8 in two subjects: design and technologies, and digital technologies
• from Years 9 to 10 in two optional subjects: design and technologies, and digital technologies
Design and technologies

Comprises two related strands:

• Design and technologies knowledge and understanding – the use, development and impact of technologies and design ideas across a range of technologies contexts: engineering principles and systems; food and fibre production; food specialisations; materials and technologies specialisations

• Design and technologies processes and production skills – the skills needed to design and produce designed solutions.
Digital technologies structure

Comprises two related strands:

• Digital technologies knowledge and understanding – the information system components of data, and digital systems (hardware, software and networks)

• Digital technologies processes and production skills – using digital systems to create ideas and information, and to define, design and implement digital solutions, and evaluate these solutions and existing information systems against specified criteria.
ICT in the Australian Curriculum

- the capability assists students to become effective *users* of ICT
- the digital technologies curriculum assists students to become confident *creators* of digital solutions
Design and Technologies (Available for use; awaiting final endorsement)

Foundation to Year 2

Foundation to Year 2 Band Description
Learning in Design and Technologies builds on concepts, skills and processes developed in the Early Years Learning Framework, revisiting, strengthening and extending these as needed.

By the end of Year 2 students will have had the opportunity to create designed solutions at least once in each of the following technologies contexts: Engineering principles and systems; Food and...

Read full description

Foundation to Year 2 Content Descriptions

Design and Technologies knowledge and understanding

- Identify how people design and produce familiar products, services and environments and consider sustainability to meet personal and local community needs (ACTDEK001)

- Explore how technologies use forces to create movement in products (ACTDEK002)

- Explore how plants and animals are grown for food, clothing and shelter and how food is selected and prepared for healthy eating (ACTDEK003)

- Explore the characteristics and properties of materials and components that are used to produce designed solutions (ACTDEK004)

Design and Technologies processes and production skills

- Explore needs or opportunities for designing, and the technologies needed to realise designed solutions (ACTDEP005)

- Visualise, generate, develop and communicate design ideas through describing, drawing and modelling (ACTDEP006)

- Use materials, components, tools, equipment and techniques to safely make designed solutions (ACTDEP007)

- Use personal preferences to evaluate the success of design ideas, processes and solutions including their care for environment (ACTDEP008)

- Sequence steps for making designed solutions and working collaboratively (ACTDEP009)
Foundation to Year 2

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Design and Technologies knowledge and understanding

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Design and Technologies processes and production skills

- Explore how technologies use forces to create movement in products (ACTDEK002)

- Explore how plants and animals are grown for food, clothing and shelter and how food is selected and prepared for healthy eating (ACTDEK003)
Key ideas

- Design thinking
- Design and Technologies
- Digital Technologies
- Computational thinking
- Project management
- Creating preferred futures

Creating solutions

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AUSTRALIAN CURRICULUM, ASSESSMENT AND REPORTING AUTHORITY
Design thinking

• underpins learning in design and technologies and used in digital technologies
• involves strategies to support the design process
• processes and production skills strand reflects the design process:
  investigating, generating, producing, evaluating, collaborating and managing
Computational thinking

- underpins learning in digital technologies and is used in design and technologies

- problem-solving method that is applied to create solutions that can be implemented using digital technologies

- involves integrating strategies, such as organising data logically, breaking down problems into parts, interpreting patterns and models and designing and implementing algorithms.
Systems thinking

- Holistic approach to the identification and solving of problems
- Components of a system, and their interactions and interrelationships
- Throughout design processes, students need to understand systems and work with complexity, uncertainty and risk
- To design digital solutions students need to understand the complexity of information and digital systems and the interdependence of components.
Systems
Why a systems approach?

Systems thinking supports students to learn science as connected concepts, rather than a collection of facts.

Scientific literacy should be approached not as a collection of isolated abilities and bits of information, but as a rich fabric of mutually supporting ideas. (AAAS, 2001)
Progression of ideas about systems…

*Atlas of Science Literacy (2007)*

**F-2**

- Most things are made of parts
- Something may not work if its parts are missing
- When parts are put together, they do things that they couldn’t do by themselves
Any system is usually connected to other systems both internally and externally. Thus a system may be thought of as containing sub-systems and as being a sub-system of a larger system.

The output from one part of a system can become the input to other parts.

Thinking about things as systems means looking for how every part relates to others.
Years 9-12

- Systems may be so closely related that there is no way to draw boundaries that separate all parts of one from all parts of the other.
- Understanding how things work and designing solutions to problems of almost any kind can be facilitated by systems analysis. In defining a system, it is important to specify its boundaries and subsystems, indicate its relation to other systems, and identify what its input and output are expected to be.
- A system usually has some properties that are different to those of its parts, but appear because of the interaction of those parts.
Mathematics

The science and technologies curriculum provides contexts within which:

- mathematical understanding
- fluency
- logical reasoning
- analytical thought
- problem-solving skills

can be applied and developed.

These capabilities enable students to respond to familiar and unfamiliar situations by employing mathematical strategies to make informed decisions and solve problems efficiently.
Engineering principles and systems
Engineering principles and systems

Engineering ‘contextualises mathematics and science principles and promotes design processes, but can also enrich students’ learning in their studies of technology, literacy, history and geography.’

(English et al, 2013: 2)
<table>
<thead>
<tr>
<th>Design and technologies: engineering principles and systems</th>
<th>Science: physical sciences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigate how forces or electrical energy can control movement, sound or light in a designed product or system <em>(ACTDEK020)</em></td>
<td>Electrical circuits provide a means of transferring and transforming electricity <em>(ACSSU097)</em></td>
</tr>
<tr>
<td>Analyse how motion, force and energy are used to manipulate and control electromechanical systems when designing simple, engineered solutions <em>(ACTDEK031)</em></td>
<td>Change to an object’s motion is caused by unbalanced forces acting on the object <em>(ACSSU117)</em> Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems <em>(ACSSU155)</em></td>
</tr>
<tr>
<td>Investigate and make judgments on how the characteristics and properties of materials are combined with force, motion and energy to create engineered solutions <em>(ACTDEK043)</em></td>
<td>The motion of objects can be described and predicted using the laws of physics <em>(ACSSU229)</em></td>
</tr>
<tr>
<td>Design and technologies processes and production skills strand</td>
<td>Science inquiry skills sub-strands</td>
</tr>
<tr>
<td>------------------------------------------------------------</td>
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</tr>
<tr>
<td>Creating designed solutions by:</td>
<td></td>
</tr>
<tr>
<td>Investigating</td>
<td>Questioning and predicting</td>
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<tr>
<td>Generating</td>
<td>Planning and conducting</td>
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<td>Producing</td>
<td>Processing and analysing data and information</td>
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<tr>
<td>Evaluating</td>
<td>Evaluating</td>
</tr>
<tr>
<td>Collaborating and managing</td>
<td>Communicating</td>
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</table>
Design task – Amusement park ride

Annotations

Identifies that friction slows the person on the slide down.

Identifies that a push can initiate movement.

Identifies that gravity pulls the person down the slide.

Annotations (Overview)

The student completes a simple report, including an annotated diagram, to communicate ideas and findings.
Design an electrical switch that is both safe and is able to be switched on and off repeatedly.
Design a toy that uses forces

<table>
<thead>
<tr>
<th>The options</th>
<th>Comment on the option you chose</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Design and make a game that moves a small object such as in the Mouse Trap game.</td>
<td></td>
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<tr>
<td>B: Design a new toy that uses forces and create a storyboard of how it moves and what forces it uses for the manufacturer.</td>
<td></td>
</tr>
<tr>
<td>C: Investigate a toy company’s claim such as “the greatest toy in the universe”. You will need to design and conduct a fair test.</td>
<td></td>
</tr>
<tr>
<td>D: Design a new component for Lego® WeDo Robotics, year 2-5 range. You must carefully explain the sensors needed.</td>
<td></td>
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</tbody>
</table>

**Design**

<table>
<thead>
<tr>
<th>What research do you need to do?</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>What resources will you need?</th>
</tr>
</thead>
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<table>
<thead>
<tr>
<th>What forces are involved in your option?</th>
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</table>

**Presentation**

<table>
<thead>
<tr>
<th>How will you present your idea/test?</th>
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<table>
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<tr>
<th>Why?</th>
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</table>
DESIGN CHALLENGES

WHIRLING WINDMILLS

DESIGN A WINDMILL THAT CAN HARNESS THE POWER OF THE WIND.

For centuries, people have used windmills to harness the power of the wind for such tasks as grinding grain and pumping water. Even today, some propose using wind farms as a form of "green" energy. Through this activity, participants act as design engineers, focusing on the testing and redesign parts of the engineering design process. They will learn about independent variables and data-driven design by testing various blade designs and configurations and placing them in a wind stream.

SUPPLEMENTAL MATERIAL

Worksheet (pdf)
Educator's Guide (pdf)
Engaging girls

• Engineers make a world of difference.
• Engineers are creative problem solvers.
• Engineers help shape the future.
• Engineering is essential to our health, happiness and safety.

www.powerofengineering.org/
Types of designed solutions

Product
Design and produce a toy with moving parts

Environment
Design and produce drawings and models for a bridge in the local community

Service
Design and produce a service to improve the delivery of food drops in emergency situations
Activity

In groups:

• select a year

• identify an aspect of physical science from the curriculum to address

• generate ideas for integrated Science and Technologies engineering tasks where students design and produce a product, service and environment
Implementation and resources
Implementation

- Facilitating implementation support discussions with stakeholders
- Developing work sample portfolios
- Working with ESA to identify resources on Scootle to support content descriptions
## Primary connections

### Year Foundation
- **Print**
  - Biological Sciences
  - Chemical Sciences
  - Earth and Space Sciences
  - Physical Sciences
    - Staying alive
    - What’s it made of?
    - Weather in my world
    - On the move

### Year 1
- **Print**
  - Biological Sciences
  - Chemical Sciences
  - Earth and Space Sciences
  - Physical Sciences
    - Schoolyard safari
    - Spot the difference
    - Up, down and all around
    - Look! Listen!

### Year 2
- **Print**
  - Biological Sciences
  - Chemical Sciences
  - Earth and Space Sciences
  - Physical Sciences
    - Watch it grow!
    - All mixed up
    - Water works
    - Push-pull

[https://primaryconnections.org.au/](https://primaryconnections.org.au/)
Science by doing

- Year 7: Science of toys
- Year 8: Energy (available July 2014)
- Year 9: Light, sound, action (available Sept. 2014)
- Year 10: Motion and energy transfer (available Dec. 2014)
Scientists in Schools欢迎您...

科学家和数学家在学校的项目是一个全国性的计划，旨在建立和支持长期的长期伙伴关系，其中小学或中学教师和科学家或数学家。合作伙伴关系灵活，可以适应不同风格和程度的参与，以适合每位参与者。请查看showcases来看看一些合作伙伴的成果。

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This site is best viewed with Adobe Flash Player 10 or later. Click here to download.
CREST

- CREativity in Science and Technology (CREST) is a non-competitive awards program supporting students to design and carry out their own open-ended science investigation or technology project.
- This education program provides a range of support material for both teachers and students.
- Email: crest@csiro.au
Intel free course

Design and engineering


Related Materials

- **Related Content**
  - STEM Resources
    - Intel provides free STEM curriculum, competitions, and online resources to encourage students' interest in Science, Technology, Engineering, and Mathematics.
  - The Journey InsideSM
    - Interactive online lessons on computers.

- **Related Topics**
Unit Summary
As a culminating activity to instruction in functions, linear equations, and proportional reasoning, algebra students explore the mathematics of bicycles. Students pair up to investigate one aspect of this two-wheeled wonder. Using bicycle-related relationships—such as wheel diameter and coasting distance, or frame tubing size and weight allowances—applied math formulas and data are explored in depth. Student teams use multimedia to share their learning for the benefit of their classmates.

Curriculum-Framing Questions

- **Essential Question**
  How does math help us understand our world?

- **Unit Questions**
  How can we use algebra to help describe the physical world?
  How can formulas help us understand bicycles and bicycling?

- **Content Questions**
  How do you create an equation given a problem of proportion?
  How do you solve an equation for a given variable?
STELR

- national secondary school science education initiative of The Australian Academy of Technological Sciences and Engineering
- hands-on, inquiry-based, in-curriculum program designed for Year 9 or Year 10 students, on the theme of global warming and renewable energy.
- Email Peter Pentland: peter.pentland@atse.org.au
One best thing

http://itunes.com/onebestthing

• Digital data: Apps to capture scientific data focusses on student use of apps on the iPad to capture data
Do **you** follow?

<table>
<thead>
<tr>
<th>Social Media Platform</th>
<th>Account Details</th>
</tr>
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<tbody>
<tr>
<td>Twitter</td>
<td>@acara.eduau and @ACARA_CEO</td>
</tr>
<tr>
<td>Facebook</td>
<td><a href="http://www.facebook.com/ACARAeduau">www.facebook.com/ACARAeduau</a></td>
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