GAME CHANGERS & CHANGEMAKERS

resource book of ideas
for National Science Week 2018

national science week 2018
11–19 August 2018
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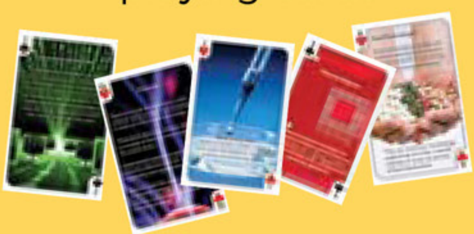

scipubs@uq.edu.au

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

CRICOS Code 00025B

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This curriculum-linked resource is designed to introduce young people to the importance of science and technology in solving problems, designing new solutions and predicting our future paths.

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All links to websites were accessed between October 2017 and January 2018. As content on the websites used in this resource book can be updated or moved, hyperlinks may not always function.

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Assistant Minister's Foreword

Australia: an 'Innovation Nation'.

Australia has a fine record of scientific excellence. Our scientific community, including research organisations and Cooperative Research Centres, continues to deliver outstanding achievements in science and research-based innovation. Many of these discoveries lead to new products, ventures and industries enabled by science.

Our scientists and innovators are game changers and change makers, and National Science Week is the perfect time to celebrate their achievements.

National Science Week gives us the opportunity to increase our communities' understanding and engagement with science, and to support young people being active in science-driven research and innovation.

'Game Changers and Change Makers' is the school theme for National Science Week in 2018. You can discover game changers and change makers from the past who have solved seemingly unsolvable problems. Today's game changers and change makers use science to solve problems, design new solutions and predict our future paths.

The Game Changers and Change Makers Resource Book of Ideas for National Science Week helps schools investigate and celebrate remarkable innovators—individuals, schools, universities, startups and science organisations—who are delivering solutions in science and helping to transform the way we live.

The Australian Government is proud to support National Science Week and I commend the Australian Science Teachers Association for another excellent publication that will encourage and inspire tomorrow's game changers and change makers.

I look forward to being updated on the inspirational stories and initiatives from within your school communities throughout National Science Week.

Senator the Hon Zed Seselja

Assistant Minister for Science, Jobs and Innovation

national science week 2018

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Introduction

National Science Week is Australia's annual celebration of science and technology.

It aims to provide an opportunity to acknowledge the contributions of scientists to the world. It also aims to encourage an interest in science among the general public, and to encourage younger people to become fascinated by the world in which we live.

The school theme of 2018 National Science Week, 'Game Changers and Change Makers', is focussed on the scientists, engineers, technologists, mathematicians, designers and innovators of the past and present.

In the eighteenth century, Sir Isaac Newton wrote "… to myself, I seem to have been only like a boy playing on a seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth laid undiscovered before me".

The shells and pebbles picked up by Newton and other scientists helped to trigger many changes. With Newton's mechanics came powerful machines, and eventually the steam engine, the motive force that spawned factories, industries, commerce, and railroads.

In the nineteenth century, intense scientific discovery was well underway and remarkable advances in science and medicine helped to enrich people's lives and empower them with knowledge, improve their health and open their eyes to new worlds.

In the twentieth century, science unlocked the secrets of the atom, unravelled the molecules of life—namely DNA—and created the electronic computer.

These epic phases of science, technology and innovation have, in the twenty-first century, enabled a dynamic era of science, technology, and innovation to evolve… one where human knowledge is doubling every ten years, where more scientific knowledge has been created than in all of human history, and where computer power is doubling every year. The Internet is growing exponentially and headlines herald new advances in computing, telecommunications, medicine, bio-technology, and space exploration. In the wake of these scientific and technological changes, entire industries, economies and lifestyles are being transformed giving rise to entirely new ones.

Today, scientists, technologists, engineers, mathematicians, designers and innovators are just like Isaac Newton was when he walked on the seashore and considered what the ocean had to offer. However, before them, and as with many of us, lies a new seashore and ocean… one of endless scientific and technological possibilities and applications, where game changers and change makers actively ask new questions, make new predictions, experiment with new ideas and reach conclusions that shape and create new discoveries, ideas, and opportunities.

The stories and narratives of scientific discoveries, and the inquiries and activities in this resource book, are drawn from historical and current day Science, Technology, Engineering and Mathematical (STEM) contexts.

In compiling this resource book and its ideas, we have tried to sample the breadth and width of topics and issues that might interest students in early childhood, primary and secondary schooling settings, as well as highlighting STEM innovations from both the past and present, in Australia and overseas, addressing human needs and answering fundamental questions about how the world works.

This resource book aims to encourage questions, inspire conversations, stimulate ideas, encourage experimentation and speculation, as well as offering a glimpse into the discoveries, technological capabilities, hopes and dreams of game changers and change makers of the past and present.

National Science Week 2018

National Science Week for schools is celebrating a number of amazing game changers and change makers in 2018.

This resource book features past and emerging research and ideas from the worlds of science, science fiction, design, technology, engineering, mathematics, medicine, marine science and agriculture in connective and sometimes surprising ways.

Today there are many scientists, technologists, researchers, engineers and mathematicians, laying the foundations for the twenty-second century. Many of them are opening up new vistas and avenues for game-changing discoveries and ideas.

This year (2018) is the 200th anniversary of the publication of *Frankenstein* by Mary Shelley. The first edition of *Frankenstein* was published anonymously in 1818 by the London printers Lackington, Hughes, Harding, Mavor and Jones, and was in three volumes. It has been said that:

'No work of literature has done more to shape the way people imagine science and its moral consequences. Frankenstein *continues to influence the way we confront emerging technologies, conceptualise the process of scientific research, imagine the motivations and ethical struggles of scientists, and weigh the benefits of innovation with its unseen pitfalls.'*

Source: **http://frankenstein.asu.edu/**

With this in mind, some of the scientific discoveries, inquiries, activities and themes used in this resource book examine game changers and change makers in the fields of bio-medical engineering, bio-technologies, prosthetics, bionics, genetic modification, ethics, and brain enhancement.

Louise Brown, born in 1978, was the world's first artificially conceived baby and in 2018 we commemorate the 40th anniversary of her birth. This was a milestone in innovative science and genetic engineering.

In 2018, most countries have established fertility units that incorporate bio-technology, genetic pre-diagnosis and nanotechnology techniques that once could have only been thought of as 'science fiction', providing society with a wide selection of fertility options available for society to utilise. Therefore, scientific discoveries, inquiries, activities and themes in this resource book also include a focus on biomedical science, genetics, ethics and biological science.

Additionally, 2018 celebrates the International Year of the Reef, through the International Coral Reef Initiative. This resource book includes scientific discoveries, inquiries, and activities about reefs, the animals and plants that live within them, as well as reef scientists and game changers, the understandings of whom help boost our collective knowledge and knowledge about these amazing marine environments.

The following icons can assist teachers locate activities and case studies that support inquiries in these areas.

- The 200th anniversary of the publication of *Frankenstein* by Mary Shelley.
- The 40th anniversary of the birth of the first test tube baby.
- The International Year of the Reef.
- Other amazing game changers and change makers who are generating new ideas and turning visions into realities.

Moments of discovery–game changers and change makers through the ages

A selection of game changers and change makers and their discoveries can be found below. These individuals have changed situations, activities and understandings in significant ways.

Astronomy | Biology | Chemistry | Engineering | Geology | Mathematics | Medicine | Physics | Technology

- **c. 3500 BC** – Middle Eastern people make bricks from clay and also fire them in a kiln to make them hard and waterproof. Before this, bricks were made from mud and straw.
- **c. 3000 BC** – People of the Indus Valley discover how the fibres attached to cotton plant seeds could be woven into a fine fabric. They invented cotton cloth.
- **c. 2600 BC** – Ancient Egyptians design and make chairs with padded seats and four legs.
- **c. 2000 BC** – Mesopotamian people design and produce wheels with a rim, hub, and spokes.
- **c. 440 BC** – Democritus suggests the existence of atoms, which are one of the smallest units of matter in the universe.
- **c. 355 BC** – Pythias, a Greek biologist and embryologist, works on an encyclopaedia of specimens of living things.
- **c. 350 BC** – Aristotle classifies, or groups, most of the animals known at that time.
- **c. 240 BC** – Eratosthenes works out the size of the Earth.
- **c. 213 BC** – Archimedes uses his discoveries in science to build war machines.
- **132** – Zhang Heng invents an instrument for detecting earthquakes.
- **400** – Hypatia of Alexandria is a Greek mathematician, astronomer, inventor and philosopher who lives in Egypt.
- **830** – Muhammad Al-Khwarizmi publishes the first textbook about modern algebra. (Although he did not employ the kind of algebraic notation used today, he used words to explain the problem, and diagrams to solve it.)
- **1000** – Avicenna makes a complete guide to medicine.
- **1250** – Roger Bacon invents the magnifying glass.
- **1320** – Alessandra Giliani is an Italian scientist who is the first woman to be recorded in historical documents as practicing anatomy and pathology.
- **1300s** – Mercuriade is a female Italian physician and surgeon who is one of the first medical authors in the Middle Ages.
- **1543** – Nicolaus Copernicus publishes his theory that the Earth goes around the sun.
- **1572** – Tycho Brahe discovers a supernova, which is an exploding star.
- **1573** – Sophia Brahe makes astronomical observations that become the basis for modern planetary orbit predictions.
- **1600** – William Gilbert proves that the Earth acts like a magnet.
- **1641** – Marie Crous introduces the decimal notation to France.
- **1609** – Galileo Galilei observes moons through a telescope and proves that the Earth goes around the sun.
- **1609** – Johannes Kepler proves that the planets go around the sun in oval-shaped paths called orbits.
- **1628** – William Harvey proves that the heart pumps blood around the body.
- **1656** – Christiaan Huygens describes the rings around the planet Saturn.

Astronomy | Biology | Chemistry | Engineering | Geology | Mathematics | Medicine | Physics | Technology

1673 Antonie van Leeuwenhoek discovers microorganisms, which are tiny life forms.

1687 Isaac Newton works out his laws of gravity (the force that holds you to Earth) and motion, also known as movement.

1690 Elizabeth Hevelius is an astronomer who completes and publishes *Prodromus Astronomiae*, a catalogue of 1,564 stars and their positions.

1700 Eleanor Glanville is an entomologist who collects some of the earliest specimens of butterflies, many of which survive in the Natural History Museum in London.

1715 Sybillia Righton Masters invents and patents the corn mill.

1735 Carl Linnaeus works out a way to group and name all living things.

1772 Antoine Lavoisier shows that oxygen is needed for breathing and burning things.

1776 Alessandro Volta discovers methane gas at Lake Maggiore, Italy.

1781 William Herschel discovers the planet Uranus.

1785 James Hutton establishes geology, which is the study of the Earth.

1786 Caroline Herschel discovers her first comet. She went on to discover seven more.

1791 Pierre-Simon de Laplace builds a mathematical model of the solar system.

1808 John Dalton invents modern atomic theory based on the idea that all matter is made up of atoms.

1800 Alessandro Volta invents the electrical battery.

1810 Nicholas Appert discovers how to preserve food.

1811 Mary Anning discovers the first complete Ichthyosaur (a fish-like marine reptile) with her brother Joseph.

1817 Baron Karl von Drais de Sauerbrun invents the 'draisienne', the first two-wheeled, rider-propelled machine.

1823 Mary Anning discovers the Long-Necked Plesiosaurus—the sea dragon.

1831 Michael Faraday invents the electric motor and the dynamo.

1842 Richard Owen invents the term 'dinosaur' for a group of reptiles that are no longer living.

1844 John Gorrie builds a machine that uses compressed air to provide a cooling breeze. It eventually becomes the refrigerator.

1845 Sarah Mather patents the first underwater telescope.

1849 Walter Hunt invents the modern safety pin.

1851 Lorenzo Langstroth develops the bee hive that is still used today.

1856 William Thompson takes the first underwater photo using a watertight box.

1859 Charles Darwin publishes his theory of evolution, which explains how species change gradually over time.

1859 Gustav Kirchhoff improves our understanding of heat and light.

1864 James Clerk Maxwell works out the laws of magnetism and electricity.

1865 Claude Bernard shows how the body works as a system.

1865 Gregor Mendel studies how plants pass on different characteristics, such as flower colour.

1866 Alfred Nobel invents dynamite.

Astronomy · Biology · Chemistry · Engineering · Geology · Mathematics · Medicine · Physics · Technology

- **1869** Dimitri Mendeleev arranges the elements—chemicals made up of one sort of atom—to create the Periodic Table.
- **1872** Ludwig Boltzmann publishes a mathematical theory relating particle motion to heat.
- **1876** Martha Coston invents the signal flare.
- **1877** Robert Koch proves that each disease is caused by its own particular germ.
- **1880s** Thomas Crapper mass produces the flush toilet.
- **1882** Antoni Gaudi begins designing the La Sagrada Familia Cathedral in Barcelona, Spain and it still isn't finished.
- **1882–83** Emily Warren Roebling is an American civil engineer who contributes to the completion of the Brooklyn Bridge.
- **1886** Josephine Cochrane invents and patents the first mechanical dishwasher.
- **1891** Eugene Dubois discovers the fossil of a human-like animal, which was probably our ancestor.
- **1892** Washington Sheffield produces the first toothpaste sold in tubes.
- **1895** Wilhelm Röntgen discovers X-rays, which allow us to see inside our bodies.
- **1897** Joseph J Thomson discovers the electron, a tiny particle found in all atoms.
- **1898** Marie and Pierre Curie discover the elements of radium and polonium, which lead to advances in medicine.
- **1899** Johanna Mestorf becomes the first female professor of archaeology in Germany.
- **1900** Max Planck discovers that energy exists in lumps, which he calls quanta.
- **1903** Mary Anderson invents windscreen wipers.
- **1905** Albert Einstein comes up with the theory of relativity, changing the way we think about time and space.
- **1907** Ernest Rutherford shows that an atom has a tiny hard core, called a nucleus.
- **1907** Alva Fisher invents the first electric washing machine.
- **1908** Melitta Bentz invents the first coffee filter.
- **1912** Alfred Wegener suggests that Earth's big land masses, the continents, have drifted apart over millions of years.
- **1913** Niels Bohr develops a theory that explains the structure of atoms.
- **1914–15** Alice Ball develops the chemistry behind the first modern treatment for leprosy.
- **1914–18** Frances Micklethwait is an English chemist, who is among the first to study and seek an antidote to mustard gas during the First World War.
- **1919** Alice Parker invents a system of gas-powered central heating.
- **1922** Annie Jump Cannon develops the Harvard Classification Scheme for stars.
- **1925** Erwin Schrödinger develops a mathematical theory about quanta, which are lumps of energy.
- **1925** Werner Heisenberg proves that measurements of tiny objects cannot be exact.
- **1925** Richard Bruce produces sticky tape by coating cellophane with glue.
- **1927** George Lemaître develops a theory, later known as the Big Bang Theory, explaining the start of the universe.
- **1928** Alexander Fleming discovers penicillin, a life-saving medicine used to treat infections.

Astronomy | Biology | Chemistry | Engineering | Geology | Mathematics | Medicine | Physics | Technology

1929 Edwin Hubble helps prove that the universe is expanding.

1930 Linus Pauling discovers how atoms are bonded together.

1932 Paul Dirac suggests that there is a material called antimatter, like matter, but with an opposite charge.

1936 Inge Lehman discovers that the Earth has an inner core.

1939 Otto Frisch and Lise Meitner discover that the core of an atom can be split into smaller parts.

1942 Enrico Fermi builds the first nuclear reactor, helping to bring about nuclear power.

1945 Percy LeBron invents the microwave oven.

1947 Maria Telkes and Eleanor Raymond invent and design the first house powered by solar energy.

1948 Richard Feynman develops an accurate version of quantum theory, which looks at matter and energy.

1951 Barbara McClintock carries out pioneering work on genes, the biological instructions that make us what we are.

1951 Rosalind Franklin is instrumental in the discovery of the structure of deoxyribonucleic acid (DNA).

1952 Grace Hopper developed the first compiler for the A–0 System programming language.

1953 James Watson, Francis Crick and Rosalind Franklin discover how DNA tells a body to grow.

1953 Stanley Miller and Harold Urey recreate the conditions for life in a model of the early Earth.

1955 Jonas Salk finds a vaccine for polio, an infectious disease.

1957 Gertrude Elion and George Hitchings make a drug that allows doctors to transplant organs.

1959 Frank Lloyd Wright designs the Guggenheim Museum in New York and it is constructed in 1959.

1960s Doug Waterhouse of the CSIRO invents the insect repellent 'Aerogard'.

1960s Stephanie Kwolek—develops Kevlar, a synthetic fibre that is used in bullet-resistant vests and crash helmets as well as sails used on sailing boats.

1961 Yuri Gagarin is the first human to journey into outer space.

1962 Rachel Carson fights for awareness and change in chemical regulations and government practices and publishes her book *Silent Spring*.

1963 Valentina Tereshkova becomes the first woman in space.

1964 Murray Gell-Mann further develops our understanding of the atom.

1965 Arno Penzias and Robert Wilson observe radio waves that prove the Big Bang Theory.

1966 Luna 9 lands on the moon and sends back the first close-up images of the moon's surface.

1967 Jocelyn Bell Burnell and Anthony Hewish discover the first pulsar, a type of star.

1968 CSIRO's research into polymer bank notes begins.

1969 Neil Armstrong and Buzz Aldrin lands and walks on the moon's surface.

1970 Venera 7 makes the first successful landing on Venus.

1971 Ray Tomlinson devises a computer program for sending messages on the ARPAnet network. This would become email.

1973 Jørn Utzon designs the Sydney Opera House and it is opened in 1973.

Astronomy | Biology | Chemistry | Engineering | Geology | Mathematics | Medicine | Physics | Technology

1974 Stephen Hawking proves that black holes in space ‘glow’, emitting a form of radiation.

1977 Voyager 1 and Voyager 2 study the outer planets of the solar system.

1977 Renzo Piano and Richard Rogers design the Pompidou Centre in Paris and it is opened in this year.

1981 Gail Martin discovers a way to isolate embryonic stem cells and cultivate them in-vitro.

1983 Francoise Barre-Sinoussi identifies the cause of AIDS.

1984 Michael Green and John Schwarz develop ‘string theory’. It aims to link quantum physics and relativity.

1986 Adele Green undertakes landmark studies in the relationship between applying sunscreen and getting melanomas.

1988 Harvard University received the first patent for a genetically modified animal.

1989 Tim Berners-Lee creates the first part of the World Wide Web.

1990 Thelma Estrin is a computer scientist and engineer who develops the pioneering work in biomedical engineering and is the first to apply computer technology to healthcare and medical research.

1995 Michel Mayor and Didier Queloz discover the first planet travelling around a star other than our sun.

1996 CSIRO’s WLAN Project Team is granted a US patent for their wireless invention ‘WiFi’ that connects computers without wires.

1997 James Dyson notices that the dust bags in conventional vacuum cleaners clog up quickly, and a few years later he markets the first bag-less vacuum cleaner.

1998 Apple launches the Apple iMac with just two steps to set up Internet access.

2000 Nance Dicciani designs the development of ultrasonic scanners for examining pregnant women.

2003 NASA works out the age of the universe as 13.7 billion years.

2004 Jerri Ellsworth invents the autodidactic (self-learning) computer chip.

2010 Linda Spilker leads the Cassini mission’s scientific investigations.

2013 Takanori Takebe and colleagues grow a working liver from a single cell, the biological unit of living organisms.

2014–15 CSIRO and Victorian biotech company Anatomincs produce a titanium heel bone implant using CSIRO’s state-of-the-art Arcam 3D printer.

2015–16 CSIRO scientists discovers lenses of interstellar gas in our galaxy.

2016–17 CSIRO scientists design and build the Australian Square Kilometre Array Pathfinder.

2016–17 CSIRO scientists develop an eReefs modelling framework that simulates and predicts the physical health of the Great Barrier Reef.

2017 CSIRO scientists produce Australia’s first carbon fibre.

Teachers and students can explore more information about game changers and change makers in mathematics by reading **The Story of Mathematics** and by viewing a website about **Famous Mathematicians**.

CSIRO's Top Ten Inventions also provides information about game changers and change makers who have worked for the scientific research organisation and delivered a range of solutions using science. Similarly, CSIRO's annual reports detail the organisation's game-changing discoveries and change-making work.

Teachers can also get the latest news about game changers and change makers by subscribing to the Australian Government's **National Science and Innovation Agenda** newsletter.

Similarly, teachers might also like to view the **Australia Beyond 2020** YouTube video in which presenters explore Australia's technological advances like fingerprint technologies, smart homes, driverless cars, the world of artificial intelligence, lifelike robots, and drone deliveries. The videos help discover technology that can make life smarter, cheaper, and more fun—beyond 2020.

It is important to note that game changers can also be a 'newly introduced element or factor that changes an existing situation or activity in a significant way'. (Source: **Merriam Webster Dictionary**)

Teachers and students, therefore, can also investigate ideas, discoveries, inventions and explorations that are changing an existing situation.

Many change makers can be found in startups, Cooperative Research Centres (CRCs), universities, schools, companies, businesses, government departments and homes.

Refer to the Technology, Entertainment and Design (TED) Talks and startups at the rear of this resource book for some links to a range of other game changers and change makers.

Teachers might also like to read about a **game changer who is a teacher of STEM**!

How to use this resource book

This resource book provides learning experiences to support your school's involvement in National Science Week 2018.

Aims

The *Game Changers and Change Makers* National Science Week resource book provides schools with opportunities to:

- explore creative processes at the heart of science, technology, engineering and mathematics, and their far-reaching influence in the world in which we live;
- develop understandings about the role of science, technology, engineering, mathematics, design and innovation play in understanding and addressing complex real-world scenarios;
- discover how science, technology, engineering and mathematics has, and is, enabling scientists, researchers, inventors, doctors, engineers, creative thinkers and entrepreneurs to leverage everyone's learning;
- discover ideas and solutions to tackle challenges as individuals, as a community and as the future decision-makers;
- discover and envision a range of creative solutions to real-world problems;
- design research projects with the ultimate goal of sharing exhibitions, events, performances and educational activities, as part of National Science Week;
- design the steps required to create exhibitions, events, performances and educational activities, as part of National Science Week;
- dream and consider the many possible solutions to deal with challenges posed;
- deliver and debrief solutions; and
- practise and reinforce the science, technology, engineering and mathematics messages delivered in the Australian Curriculum Learning Areas, General Capabilities and Cross Curriculum Priorities.

In schools, there is scope for teachers to integrate this resource book into their existing classroom programs.

The learning experiences

Teachers can use the learning experiences to plan, publicise, provoke, stimulate, support and inspire their National Science Week festivities. It is recommended that the activities are read and considered well before National Science Week as many involve preparation and timing considerations.

The 'Solution Fluency' based project-based learning (PBL) activities require many weeks work. The standalone activities, videos, animations, and fun ideas for science stations referenced on page 13 can be undertaken during National Science Week.

The resource book includes ideas to support students' involvement in investigating, exploring, experimenting, designing, creating and communicating their understandings about past and present **game changers** and **change makers**.

The resource book is complemented by a **National Science Week journal** that can be downloaded and printed. It is intended for older students to record their ideas, from defining the problem posed in the suggested activities to debriefing the solutions they devise.

The standalone activities and ideas for classroom work and science fairs that are found after the title 'Like a game changer, have a go at this!' involve the purposeful application of knowledge, experience and resources to create products, services and some environments.

The goal in providing this range of activity types is to provide students with exciting and creative educational experiences, so that they can go off and become creators and future game changers and change makers.

The 'At a glance' section (page 13) gives an overview of activities and a list of the videos linked to the resource book.

The 'Looking for PBL tasks for National Science Week' section (page 14) provides an overview of what is involved in each PBL task that uses the 'solution fluency' methodology in the resource book.

Curriculum focus

This learning resource has a variety of student activities that link to the Australian Curriculum for science, technologies, engineering, mathematics, history, and the arts. It also has many opportunities to integrate the Australian Curriculum's General Capabilities and Cross Curriculum Priorities into a school's learning programs.

STEM, STEAM, PBL, and the use of Tinker Spaces, Explorer Spaces and Maker Spaces are supported in the ideas in this book.

Teaching and learning about Game Changers and Change Makers can therefore be integrated into a range of learning areas and learning contexts in the lead-up to and during National Science Week.

A suggested learning sequence

The PBL learning sequences used in some of the learning activities in this book are underpinned by the work of Lee Crockett.

PBL sequences use 'solution fluency' through six phases: Define, Discover, Dream, Design, Deliver and Debrief. The phases of the model are based on the '21st Century Fluencies' created by Crockett *et al.* (2011).

The Essential Fluencies are outlined extensively in the 2016 book *Mindful Assessment* by L Crockett and A Churches, which is published by Solution Tree. See also **Solution Fluency**, Global Digital Citizen Foundation website, and the solution fluency video '**Solution Fluency'** on YouTube (3:13 min).

The fluencies are:

- **Define:** The 'Define' phase begins with lessons that intellectually engage students with a challenge, problem, question and task. This phase captures their interest, provides an opportunity for them to express what they know about the topic, share understandings being developed, and helps them to make connections between what they know and the new ideas.
- **Discover:** The 'Discover' phase includes activities in which students can explore, investigate, research, read, discuss, gather, organise and compare knowledge and data. They grapple with the challenge, problem, question or phenomenon and describe it in their own words. This phase provides a context and enables students to acquire a common set of experiences that they can use to help each other make sense of the new knowledge or understandings.
- **Dream:** The 'Dream' phase enables students to imagine and develop possible solutions and explanations for the challenge, problem, question and task they have experienced. The significant aspect of this phase is that the students' explanations follow substantive conversations and higher-order thinking experiences.
- **Design:** The 'Design' phase provides opportunities for students to apply what they have learned to new situations, to map production processes and so develop a deeper understanding of the challenge, problem, question or phenomenon. It is important for students to extend explanations and understandings, using and integrating different modes such as diagrammatic images, written language and media.
- **Deliver:** The 'Deliver' phase has two stages—production and publication or presentation. In the production phase, the task comes to life—this is the doing phase. At the end of this phase, the student task should be completed. Next, they present or publish their work sample to an audience.
- **Debrief:** The 'Debrief' phase provides an opportunity for students to revisit, review and reflect on their own learning and new understanding and skills. This is also when students provide evidence for changes to their understanding, beliefs and skills.

Source: ***Solution Fluency****, Global Digital Citizen Foundation website.*

At a glance…

The following overview chart provides page references and links to standalone activities, movies and ideas for science fairs. The number in brackets after each activity denotes the page number.

Activity Type–**Standalone activities for Science Fairs**

Like a Game Changer have a go at...

Foundation–Year 2	Year 3–Year 6	Year 7–Year 10
Creating a mask (p22)	Designing a bee hotel (p33)	Designing a system to manage waste (p57)
Making thaumatropes (p23)	Building a suspension bridge (p34)	Designing a trash rack (p58)
Making a Pokémon reef creature (p24)	Using augmented reality colouring tools and techniques (p36)	Creating a talking avatar (p62)
Designing a plane that can fly (p28)	Designing a creature or robot (p42)	Designing a new space or structure (p80)
Making something float or sink (p29)	Building a pyramid (p46)	Design mini STEM ventures (p81)
Designing a bee hotel (p33)	Making a moving reef animal (p49)	
Building a suspension bridge (p34)	Designing artwork about game changers (p50)	
Reading books about game changers (p36)	Watching cells at work (p53)	
Creating art and craft about game changers (p36)	Designing a system to manage waste (p57)	
Acting out puppet shows about game changers (p36)	Designing a trash rack (p58)	
Dressing up and dancing with a game changers theme (p36)	Creating a talking avatar (p62)	
Creating collages about game changers (p36)	Watching genetic traits at work (p65)	
Using augmented reality colouring tools and techniques (p36)	Extracting DNA (p66)	

Activity Type - **Videos**

Science Rules YouTube (3:08 min)	Science Rules YouTube (3:08 min)	The life cycle of a plastic bottle. YouTube (4:06 min)
5 Famous Inventors YouTube (3:35 min)	Make a pyramid by viewing this video. YouTube (4:03 min)	How we can keep plastics out of the ocean YouTube (3:10 min)
Newton's Discovery – Sir Isaac Newton YouTube (4:43 min)	I Am The Earth YouTube (3:56 min)	Taking action against ocean plastic. YouTube (4:26 min)
Galileo Galilei YouTube (6:53 min)	The life cycle of a plastic bottle YouTube (4:06 min)	NASA—A Human Adventure YouTube (14:16 min)
Charles Darwin YouTube (7:20min)	How we can keep plastics out of the ocean YouTube (3:10 min)	The LUKE Arm that helps injured war veterans. YouTube (2:23 min)
Marie Curie YouTube (7:17min)	Taking action against ocean plastic YouTube (4:26 min)	Alternative Limb Project YouTube (4:34 min)
Amazing Kid Inventions! YouTube (2:57 min)	NASA—A Human Adventure YouTube (14:16 min)	Australia's Great Southern Reef Ocean Imaging (1:05 min)
All About Bees. An Interesting Picture Book for Kids YouTube (3:07min)	The LUKE Arm that helps injured war veterans. YouTube (2:23 min)	Leonardo DiCaprio's moving speech on climate, YouTube (1:05 min)
Farming Bees. Bzzzzz (7:34 min)	Alternative Limb Project YouTube (4:34 min)	Imagine a World without Toilets YouTube (1:40 min)
The Honey Files: A Bee's Life YouTube (16:05 min)	Australia's Great Southern Reef Ocean Imaging (1:05 min)	Great Barrier Reef YouTube (3:15 min)
Bees YouTube (3:05 min)	Leonardo DiCaprio's moving speech on climate YouTube (1:05 min)	Can We Save the Reef ABC (57 min)
Australia's Great Southern Reef YouTube (1:35 min)	Imagine a World without Toilets YouTube (1:40 min)	

Looking for PBL tasks for National Science Week?

The following information provides an overview of what is involved in each PBL sequence that uses the 'solution fluency' approach in this resource book.

Foundation–Year 2

Activity 1: Curiosity is what you've got! (page 19)

In Activity 1, students are challenged to think like a scientist and try a number of science activities, ask some scientific questions, make a book of 'Fantastic Facts' describing what they have learned and share it with the National Science Week team in Canberra.

Students:

- investigate how scientists are curious, investigate questions, and make fascinating discoveries;
- use Tinker Spaces, Tinker Trays or Maker Spaces and explore a game changer or change maker in science, technology, engineering or maths and discover a fantastic fact;
- learn about **Carl Linnaeus** who invented a clear and simple naming system that could be used for living things;
- learn about **Roger Bacon**, who in 1250 invented the magnifying glass, and then observe objects under magnifying glasses;
- discover how a female scientist named **Eleanor Glanville** used her love of science to collect the earliest specimens of butterflies and how **Maria Sibylla Merian**, a botanical illustrator, drew scientific illustrations that feature in many famous paintings;
- learn about **Gustave Eiffel**, **Emile Nouguier** and **Maurice Koechlin**, who designed and built the Eiffel Tower in Paris, and **Sophie Germain**, whose work was used in the construction of the tower. Students use marshmallows and spaghetti to make a tower.

Activity 5: Game changers throughout the ages (page 25)

In Activity 5, students create a work sample using text, photographs or illustrations showing five STEM-related discoveries that may have been made in the past or present to share as part of National Science Week.

Students:

- view a video and learn about game changers like **Benjamin Franklin**, the **Wright Brothers**, **Leonardo da Vinci**, **Alexander Graham Bell**, **Ada Lovelace**, **Sir Isaac Newton**, **Galileo Galilei**, **Charles Darwin** and **Marie Curie**;
- research discoveries and inventions that have been investigated and think about what they might do as scientists, technologists, engineers and mathematicians of the future;
- design and make their National Science Week work sample;
- visit a local preschool, kindergarten, foundation class or day-care centre and share and discuss the ideas about game changers and change makers with younger children;
- share the names and discoveries of the STEM-related discoveries that have been made in the past or present.

Activity 8: Game changers–honey bees (page 30)

In Activity 8, students learn about game changers like Lorenzo Langstroth. They also learn about the honey bee, what they produce and what they do to help plants grow. Students then design and produce a model of a honey bee and use it to spread the word about how vital bees are for the wellbeing of our food and environment as part of National Science Week.

Students:

- learn about honey bees;
- make a model of a honey bee;
- host a National Science Week Honey Bees Day and invite students, teachers and parents to discover what the class knows about honey bees and how vital bees are for the wellbeing of our food and environment.

Year 3–Year 4

Activity 1: Think like a game changer! (page 39)

In Activity1, students think like a scientist and try a number of science activities: ask some scientific questions, hypothesise, experiment, analyse and ask questions about what happened in the experiment, form conclusions and ideas, and then make a paper slide video and describe what they have learned about science and its game changers.

Students:

- learn about game changers like **Carl Linnaeus**, who published a system for classifying living things, and **Richard Waller** who created the first Dichotomous Key;
- discover how **Archimedes** worked out how things float;
- learn about how scientists like **Pythagoras**, **Leonardo da Vinci** and **Amalie Emmy Noether** used symmetries;
- discover that **Gustave Eiffel**, **Emile Nouguier** and **Maurice Koechlin** designed and built the Eiffel Tower, and learn how **Sophie Germain's** work on electricity was used in the construction of the tower;
- use Maker Spaces to make a hypothesis, create a key, make a boat that floats, create a symmetrical design and build a tower;
- design and make a paper slide that includes the name of the game changer and what they discovered, designed or invented as well as explain their understanding of the science, technology or maths they choose to showcase as part of National Science Week.

Activity 3: May the force be with you (page 43)

In Activity 3, students use **Isaac Newton's** ideas and their own thinking to help others understand what makes things move and what gravity is. They also demonstrate this to other classes during National Science Week.

Students:

- explore forces and gravity;
- experiment with water bottles, paper, tissue paper, magnets, string, straws, balloons and paper clips;
- design a demonstration to show what makes things move, what gravity is, and host a National Science Week Day.

Activity 5: Let's get preserving (page 47)

In Activity 5, students investigate a range of preserving methods and recipes, then illustrate the steps involved in preserving a food. They also contribute a recipe and the steps involved in preserving a food type to a 'School Family Cook Book' for a class fundraiser.

Students:

- learn about the game changer **Nicholas Appert** who developed ways of preserving foods;
- explore technologies and equipment used in preserving food;
- think about a food that they could preserve that is grown at school or at home;
- research and investigate the methods and technologies used for preserving food grown at school or home and record their design ideas;
- write a procedure that shows how to use the designed solution;
- evaluate their solution, and suggest improvements where necessary, giving reasons;
- produce and share their recipes as part of a 'School Family Cook Book';
- Host a Preserving The Year 3/4 Way Day and invite students, teachers and parents to discover what the class knows about preserving methods used in modern and traditional societies.

Activity 8: Engineering Academy (page 51)

In Activity 8, students design and build a bridge that can support a toy car.

Students:

- explore how architects and engineers design and build bridges;
- investigate iconic Australian bridges;
- learn about game changers who designed and built a range of bridges;
- investigate arch, suspension, and cantilever bridges;
- use Minecraft, Lego® or materials like newspaper, cardboard, pipe cleaners, string, paper clips, straws, masking tape, glue and tape to design and make a bridge.

Year 5–Year 6

Activity 1: Marine debris and Australian reefs (page 54)

In Activity 1, students create a blog, poster and brochure designed to raise awareness of the way local people can better protect marine wildlife that lives within the waters of Australian reefs by reducing the amount of marine debris that pollutes waterways and oceans.

Students:

- learn about Australian reefs, marine debris and game changers who are involved in reducing or eliminating plastics from oceans;
- design and create their chosen digital or non-digital method of spreading awareness;
- share the blog, poster and a brochure that describes the best ways to reduce the amount of marine debris that is washed or blown from the land into the sea, abandoned or lost by recreational and commercial fishers, and disposed of or lost by ships at sea.

Activity 4: Looking into space (page 59)

In Activity 4, students research astronomers and the people and technologies used in space exploration. They also use science, technology and art to create a piece for a pop-up Science Week Exhibition titled 'Looking into Space', which visitors of all ages can be invited to enter and explore.

Students:

- view art installations;
- learn about game changers like astronomers, space probes, the first humans in space, and refracting telescopes;

- research the Australia Telescope National Facility;
- design and present their artwork for the pop-up Science Week Exhibition titled 'Looking into Space'.

Activity 7: Cybernetics technology (page 63)

In Activity 7, students explore the issues of body modification, enhancement and transformation. They consider how to get people thinking about ways the human body is being modified, enhanced and transformed as part of National Science Week.

Students:

- explore robotic limbs, prostheses, medical devices and consider issues of body modification, enhancement and transformation;
- design and deliver work samples to bring awareness to the theme 'Game Changers and Change Makers' and to the issues of responsible body modification, enhancement and transformation.

Year 7–Year 10

Activity 1: The bionics boom (page 69)

In Activity 1, students explore the evolution of computer power and computer applications that can control muscle movements, restore vision for the blind, and hearing for the deaf. They investigate microprocessor technologies that aid in the design of possible new applications, which can benefit medical science as well as bring awareness of these opportunities as part of National Science Week.

Students:

- learn about game-changing ideas including intelligent prosthetics, cyborgs, bionic kidneys, bionic eyes, bionic ears, and bionic arms integrated into the bones, nerves and muscle tissue;
- design work samples that feature an application such as a microprocessor technology that can be implanted into the human body to aid people with special needs and disabilities;
- set up a 'Bionics' multimedia presentation for audiences to view and learn from as part of National Science Week.

Activity 2: Reefs at risk (page 71)

In Activity 2, students research threats to reefs and study ways in which scientists and artists have communicated how we can protect, manage and conserve reefs. They use science, technology and art to create a work sample for a pop-up Science Week exhibition titled 'Reefs at Risk', which visitors of all ages will be invited to enter and explore.

Students:

- view art installations;
- learn about game changers involved in reef research and science;
- design and present their artwork for the pop-up Science Week exhibition titled 'Reefs at Risk'.

Activity 3: What choices do we have? (page 74)

In Activity 3, students consider what is ethically and socially responsible in a world of DNA testing and cloning.

Students:

- discover information about how we re-engineer organisms like mice, dogs, cats, cattle, carrots, viruses and cotton as well as grains like corn and wheat;
- use a SWOT analysis to identify vital areas to either emphasise or improve in terms of genetically engineering organisms;
- investigate cloning;
- use Edward de Bono's Six Hat Thinking and Positive, Negative, Interesting (PMI) techniques to analyse the associated advantages and disadvantages as well as interesting welfare and/or ethical features or considerations being used in cloning and genetic engineering contexts;
- design their solution to explain and help others understand what they think is socially and ethically responsible when manipulating cells, changing the structure of DNA and producing new organisms;
- host a Investigating DNA Day as part of National Science Week.

Activity 4: Make a positive difference (page 77)

In Activity 4, students educate the broader community to understand how game changers and change makers advocate for a stable climate, clean water supplies, sanitary waste disposal, clean oceans, and active and informed citizens.

Students:

- learn about game-changing designs and game changers involved in addressing issues like climate change, clean water supplies, sanitary waste disposal and clean oceans;
- design and deliver work samples to audiences during National Science Week and discuss the issues of global environmental change and the game changers and change makers who advocate concerning the issues and create real change.

GAME CHANGERS & CHANGEMAKERS

For the

Early Years of Schooling

Foundation–2

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Activity 1: Curiosity is what you've got!

Overview: *Explain to the class that they will be investigating how scientists are curious, investigate questions, and make fascinating discoveries.*

Background science for students: What is the 'scientific method'?

Scientists ask lots of questions about the world around us, and probably you do as well. One method, that scientists use to answer questions is called the scientific method which is the process of asking questions, predicting, experimenting, observing and reaching conclusions.

This is how it works. First, they try to predict what the answer to a question might be. This is called an hypothesis. Often, they base this hypothesis on what is known. Sometimes scientists then carry out experiments to see what will happen. They use the results of the experiments to work out if their hypothesis was correct. Regardless of the outcome, science will have progressed.

The essential question:

What happens when we understand how scientists are curious, investigate questions and make fascinating discoveries?

The scenario:

Today, like long ago, science rules the world.

The clothes we wear, the food we eat, the buildings we live in and the digital devices we use all depend on science.

Science keeps us healthy as well and it is thanks to medical science and the way scientists think, that we understand a lot about the cells in our bodies. It is also how we have learnt to identify and treat diseases and build incredible machines.

Your challenge is to think like a scientist and try a number of science activities, ask some scientific questions, make a book of 'Fantastic Facts' describing what you have learned and share it with the National Science Week team in Canberra. Are you up for the challenge?

If so, then write/scribe a fantastic fact and the scientific questions that you investigated. For example, in 1250, **Roger Bacon** invented the magnifying glass. Later, as a class, make the book of 'Fantastic Facts' and share it as part of National Science Week!

A suggested learning process:

Define:

Capture students interest and show the video **Science Rules!** YouTube (3:08 min). Listen to the song then talk about and display the different areas of science it mentions. For example, geology, chemistry, biology, archaeology, astronomy and physics. Display these areas of science and scribe what students think they might be about. For example; geology is about rocks.

Invite students to explore a Tinker Space, Tinker Tray or Maker Space where they can explore science, technology or engineering. Set up a tray or space with recyclables, pop sticks, pipe cleaners, paper, glue, tape, rocks. velcro, circuits, magnifying glasses, crystals, animal bones, bubbles, feathers, tree bark, old keyboards, model animals, etc.

Ask the question: 'What happens when we are curious like scientists and ask questions, investigate questions, and make fascinating discoveries?'

Before any research is undertaken, ask students to tell the class what they intend to do. For example, '... these are the questions we are going to find out about'.

List questions on a wall chart as they arise.

Encourage and support students to investigate materials in the Tinker Space, Tinker Tray or Maker Space, and observe, experiment, classify, discuss, ask questions, record both questions and findings, and reflect on understandings.

Ask students to describe their understanding of the task/challenge through discussion and, if appropriate, a written (scribed) statement.

Discover:

Invite students to explore a Tinker Space, Tinker Tray or Maker Space where they can explore a game changer or change maker in science, technology, engineering or maths and discover a fantastic fact.

For example:

Tinker Tray 1 can be set up with pictures of different plants and animals. Include reptiles, mammals, marsupials, fish, birds, trees, flowers, grasses, ferns, fungi, vegetables and fruiting trees. If these are not available, bring in collections of bones, for example, lamb, fish or the bones of birds including chickens.

Game changer information provided to students could include: 'Carl Linnaeus invented a clear and simple naming system that could be used for living things.'

Ask the students working in pairs or small groups to group or classify the pictures or bones.

Ask students to share and compare their groupings or classifications.

Invite students to justify their groupings, and discuss ways in which grouping things can be useful.

Tinker Tray 2 can be set up with magnifying glasses. Add a piece of lettuce, some salt, some sugar dissolved in water, a beetle's wing, a dog's hair, bread crumbs, leaves, flowers, fruit, bark, a part of a root, etc. for students to observe, talk about, and compare observations.

Game changer information provided to students could include: 'In the year 1250, **Roger Baco**n invented the magnifying glass. This also led to later inventions such as the microscope and reading glasses.'

Ask students to observe objects under the magnifying glasses. Let students discover that, although things look larger through the lens, they really remain the same size.

Ask students to closely examine a few items and write down what they see.

Then ask students to examine the same items through a magnifying glass and make notes about what they see.

In pairs, students can choose one item and undertake the following:

- draw the item;
- draw the item as seen through a magnifying glass; and
- describe any differences between the two views.

Tinker Tray 3 can be set up with a mirror, paints, paper, rulers, pencils, and images of birds, or insects (including butterflies) and flowers.

Game changer information provided to students could include: '**Eleanor Glanville** was interested in the natural sciences. She loved to study caterpillars and butterflies.' '**Maria Sibylla Merian** was a botanical illustrator and her scientific illustrations feature in many famous paintings.' Her illustrations can be seen in this **video** (11.33 min).

Introduce the idea of symmetry or evenness by asking students to look at themselves in a mirror and see how their left half and right half roughly match.

Talk about how, if we could fold ourselves in half, our right half would roughly match our left half. Ask students to draw an imaginary line dividing their body in half vertically through their nose and belly button, and explore symmetry.

In pairs, ask students to explore their left and right hands. Do they roughly match?

In pairs, explore symmetrical shapes in illustrations of butterflies, birds and flowers. Ask pairs of students to investigate and fold each illustration in half.

Alternatively, using a piece of A4 paper, ask students to fold the piece of paper in half and place a blob of paint on one side of the paper, and then ask them to fold it again. Does it create a symmetrical or even design? Can they design a butterfly?

Invite students to be a botanical illustrator and to design a butterfly, flower or bird.

Tinker Tray 4 can be set up with marshmallows, a strip of masking tape and lots of pieces of uncooked spaghetti.

Game changer information provided to students could include: 'In June 1884, **Gustave Eiffel**, **Emile Nouguier** and **Maurice Koechlin** had the idea to build a very tall tower. They designed and built the Eiffel Tower in Paris. **Sophie Germain**, a female mathematician who did early work on electricity, was also involved in building the tower.'

Ask students to use the spaghetti, tape and marshmallows to build a tower.

Dream:

Ask students to imagine the steps involved in designing a 'Fascinating Fact' page that will be part of a class book.

Challenge students to think about the materials, tools, and equipment they will need to design their individual work samples.

Design:

Ask students to design their work sample's layout and decide on its title.

Ask students to write their text and plan what illustrations they will use.

Invite a peer class group to the class and ask students to explain their work sample's concepts to that audience and seek feedback on their ideas.

Deliver:

Ask students to create their 'Fantastic Fact' page and include the scientific questions that they investigated. For example, in 1849, Walter Hun invented the safety pin.

Prepare a class book of students' work samples.

Visit a local preschool, kindergarten, Foundation class or day-care centre and share the class book and discuss the ideas about game changers and change makers with younger children.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek. Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to recall what fascinating facts they discovered.

Talk about what they might still like to discover and whether there is anything they would like to research or explore more deeply.

Ask students to describe their favourite part of creating a work sample and sharing it with others as part of National Science Week.

Links to the Australian Curriculum

Science

Foundation, Year 1 and Year 2

Science as a Human Endeavour—Nature and development of science

Science involves observing, asking questions about, and describing changes in, objects and events ACSHE013 ACSHE021 ACSHE034

Science as a Human Endeavour—Use and influence of science

People use science in their daily lives, including when caring for their environment and living things ACSHE022 ACSHE035

Foundation

Science Inquiry Skills

Respond to questions about familiar objects and events ACSIS014

Participate in guided investigations and make observations using the senses ACSIS011

Engage in discussions about observations and represent ideas ACSIS233

Share observations and ideas ACSIS012

Year 1

Science Inquiry Skills

Respond to and pose questions, and make predictions about familiar objects and events ACSIS024

Participate in guided investigations to explore and answer questions ACSIS025

Use informal measurements to collect and record observations, using digital technologies as appropriate ACSIS026

Use a range of methods to sort information, including drawings and provided tables and through discussion, compare observations with predictions ACSIS027

Compare observations with those of others ACSIS213

Represent and communicate observations and ideas in a variety of ways ACSIS029

Year 2

Science Inquiry Skills

Pose and respond to questions, and make predictions about familiar objects and events ACSIS037

Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources ACSIS038

Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate ACSIS039

Use a range of methods to sort information, including drawings and provided tables ACSIS040

Through discussion, compare observations with predictions ACSIS214

Compare observations with those of others ACSIS041

Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play ACSIS042

General Capabilities:

Literacy, Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability, Ethical understanding. Source: (ACARA, 2015)

Activity 2:

Can you create a mask of Frankenstein's creature?

***Mary Shelley** wrote her book titled* Frankenstein *in May 1817 and it was published in January 1818.*

Be creative like **Mary Shelley** and design and make a mask of Frankenstein's creature.

You will need:

- Sheets of A4 paper
- Pencils
- Scissors
- Coloured felt or foam
- Colouring pens
- String or elastic

What to do:

- Fold the paper in half and draw one side of the creature's face with the fold going down the middle.
- Cut around the outline, leaving the fold intact.
- Unfold the symmetrical face and lay it on the felt or foam, then cut round it.
- Decorate it.
- Make holes on either side and attach elastic or string.

Maths fact: *Symmetrical shapes are made of matching, facing parts placed around one or more axes.*

Activity 3:
Can you create a thaumatrope?

National Science Week is celebrating the International Year of the Reef.

A long time ago, a scientist named **Aristotle** classified, or grouped, most of the animals known at that time.

Using the photos on this page, taken by Carl Charter while diving in the waters of the Great Southern Reef, think and write about the following questions.

What is this place? What might live there?

Can you see and list animals that can be found living in this Reef?

Make 'thaumatropes'.

See instructional video **How to make a thaumatrope**, YouTube (1:08 min).

On a small piece of round card, draw the part of the reef where your chosen animal lives.

On another piece of round card draw the animal.

Glue the two pictures, back to back, on the top of a plastic straw

Spin the straw between the palms of your hands so that the pictures spin.

The animal will appear to be 'in' the reef habitat. Show your thaumatropes to others during National Science Week.

Photos courtesy of Carl Charter

Activity 4:
Which Australian reef creatures might make the best Pokémon?

***Satoshi Tajiri** is a game-changing Japanese video game designer, best known as the creator of Nintendo's Pokémon franchise.*

Find out about reef creatures, where they live and how they grow. Watch these videos:

Australia's Great Southern Reef on YouTube (1:35 min) and **Great Barrier Reef** on YouTube (3:15 min).

Explore Pokémon and all of their powers, moves and abilities.

Design and illustrate your very own Australian reef Pokémon card.

Hold a science exhibition and show your Australian reef Pokémon to a class learning Japanese.

Photos courtesy of Carl Charter

Activity 5: Game changers throughout the ages

Overview: *Explain to the class that they will be exploring a range of discoveries that scientists, mathematicians, researchers and inventors have made in the past. Their task is to choose five discoveries to help other children in the school to better understand and appreciate what they can do as the scientists, technologists, engineers, and mathematicians of the future.*

Background science for students: What is 'science'?

Have you ever wondered why the Earth has an atmosphere, rivers, seas, clouds, trees, soil, mountains, deserts, and all kinds of animals? If you have ever asked questions like this about the natural world, then you were thinking like an inquiring scientist. The word 'science' comes from the Latin word that means 'body of knowledge'. Science is a way of gathering knowledge about the world and universe that starts with a question and then tries to answer that question with lots of evidence and logic.

Scientists are continually testing and revising their ideas, and as new knowledge is gained or new observations are made, old ideas may be replaced with new ideas.

Many centuries ago, people were asking themselves the same questions you ask yourself today. But the answers have not always been the same. After all, scientists build on the discoveries of other scientists.

The essential question:

What happens when we understand how scientists, technologists, engineers, and mathematicians use science, technology, engineering and maths (STEM) in their amazing activities?

The scenario:

National Science Week is searching for schools to help other children to better understand and appreciate what they can do as the scientists, technologists, engineers, and mathematicians of the future.

In the past, scientists, technologists, engineers, mathematicians, the church and governments (all of them grown-ups) thought of ways to explain how the world works. Now it's your turn to investigate what five of these game changers discovered. What kind of investigator will you be and will you investigate the discoveries of scientists, technologists, engineers or mathematicians of the future?

What investigations can assist you in your mission?

Your challenge is to use other game changers and change makers' ideas and your own thinking to help other children in the school better understand and appreciate what they can do as the scientists, technologists, engineers and mathematicians of the future. Are you up for the challenge?

If so, then create a work sample using text, photographs or illustrations showing five STEM-related discoveries that may have been made in the past or present to share as part of National Science Week. You must include the name of the game changer or change maker, what they discovered and two or more ideas about what young people can do as the scientists, technologists, engineers and mathematicians of the future.

A suggested learning process:

Define:

Capture students' interest and talk about how over many centuries scientists, technologists, engineers and mathematicians have discovered and invented all kinds of things.

View a video from the Junior Mojo series about **5 Famous Inventors** on YouTube (3:35 min). Ask students to recall the identities of some of these game changers. For example: **Benjamin Franklin**, the **Wright Brothers**, **Leonardo da Vinci, Alexander Graham Bell** and **Ada Lovelace**.

Replay the video on the electronic whiteboard, stopping after each inventor has been discussed and talk about each inventor's discoveries.

Brainstorm a list of other known inventors who could also have featured on the Junior Mojo episode and talk about their amazing discoveries.

Ask students to articulate their understanding of the task/ challenge through discussion and if appropriate a written (scribed) statement.

Discover:

Pose the questions: 'Which scientists, technologists, engineers and mathematicians do we know?', 'What are their names?', 'What did they discover or invent?', 'When did they make their discoveries?'.

Discuss students' ideas.

Play the video **Newton's Discovery—Sir Isaac Newton** on YouTube (4:43 min) and discover more about one of the most influential mathematicians and scientists of all time. The video presents the story of gravity and **Newton's** three laws of motion.

Discover more about another game changer who was a scientist, mathematician and inventor named **Galileo Galilei** on YouTube (6:53 min). Talk about how **Galileo Galilei's** scientific aim was to prove that the Earth travelled around the sun, not the other way around as people at that time believed, and how he designed and used telescopes to explore the solar system. Discuss how he discovered moons travelling around the planet Jupiter, which made him realise that not everything circled the Earth, and how this helped him argue that the sun was at the centre of the solar system.

Explore the talents of **Charles Darwin** on YouTube (7:20min). **Charles Darwin** was a naturalist, who sailed on a ship called the *HMS Beagle* for many years to find and study animals. Discuss how Darwin's scientific aim was to show that over many years plants and animals on Earth evolved, or gradually developed, from simpler ones. Talk about how Darwin proved that today's plants and animals developed from simpler ones through a slow process stretching over millions of years called 'evolution'.

Delve into the game-changing work of **Marie and Pierre Curie**. **Marie Curie** on YouTube (7:17min). They researched a number of chemical elements, which Marie named radium and polonium.

Create displays to show what has been discussed and learned, and how game changers and change makers can make a difference.

Find out about young students in schools and the amazing discoveries and inventions with which they are involved. For example, view an episode of *The Ellen Show*, **Amazing Kid Inventions!** on YouTube (2:57 min).

Discuss the research, discoveries and inventions that have been investigated and ask students what they think they might do as scientists, technologists, engineers and mathematicians of the future. Ask students to record their ideas.

Ask students to visualise being a future scientist, technologist, engineer, or mathematician. What might they discover, invent, or research? What problem might they currently know of and that they might try to solve? How might they approach the challenge?

Invite students to undertake some additional 'scientific research' for their work sample.

Dream:

Ask students to visualise their work sample. Will it be high-tech, low-tech or no-tech? Might they use a digital device to create it or a poster board and pens? Might it be possible to create a video, song or multimedia presentation?

Brainstorm and develop possible solutions for creating a work sample about five STEM-related discoveries that have been made in the past or present. This should involve: the name of the game changer or change maker, what they discovered, and two or more ideas about what young people can do as the scientists, technologists, engineers and mathematicians of the future.

Ask students to imagine the actions and steps involved in making their work sample.

Challenge students to think about the materials, tools, and equipment they will need to make it.

Ask students to imagine how their work sample and the ideas and discoveries it includes might feature in the school's National Science Week activities.

Invite students to think about how they might present their work sample during National Science Week.

Design:

Ask students to design their work sample's layout and decide on its title.

Ask students to draft their text and plan what illustrations will complement the text.

Invite a peer class group to the class and ask students to explain their work sample's concepts to this audience and seek feedback on their ideas.

Deliver:

Create the work samples about five STEM-related discoveries that have been made in the past or present. These should include: the name of the game changer or change maker, what they discovered, and two or more ideas about what young people can do as the scientists, technologists, engineers and mathematicians of the future.

Prepare a display of students' work samples.

Visit a local preschool, kindergarten, Foundation class or day-care centre and share and discuss the ideas about game changers and change makers with younger children.

Read aloud and share the names and discoveries of the STEM-related discoveries that have been made in the past or present, stopping periodically to ask younger students to find the picture, or object or idea that was mentioned.

Explain to the audience what young people can do as the scientists, technologists, engineers and mathematicians of the future.

Share photos and the students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek. Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to recall what they discovered about game changers throughout the ages.

Talk about what they might still like to discover and whether there is anything they would like to invent, research or delve more deeply into.

Ask students to describe their favourite part of creating a work sample about STEM discoveries and sharing it with others as part of National Science Week.

Case study

Check out some STEM-based discoveries made by kids in the '**Little Big Ideas'** competition.

Links to the Australian Curriculum

Science

Foundation, Year 1 and Year 2

Science as a Human Endeavour—Nature and development of science

Science involves observing, asking questions about, and describing changes in, objects and events ACSHE013 ACSHE021 ACSHE034

Science as a Human Endeavour—Use and influence of science

People use science in their daily lives, including when caring for their environment and living things ACSHE022

Foundation

Science Inquiry Skills

Respond to questions about familiar objects and events ACSIS014

Participate in guided investigations and make observations using the senses ACSIS011

Engage in discussions about observations and represent ideas ACSIS233

Share observations and ideas ACSIS012

Year 1

Science Inquiry Skills

Respond to and pose questions, and make predictions about familiar objects and events ACSIS024

Participate in guided investigations to explore and answer questions ACSIS025

Use informal measurements to collect and record observations, using digital technologies as appropriate ACSIS026

Use a range of methods to sort information, including drawings and provided tables and through discussion, compare observations with predictions ACSIS027

Represent and communicate observations and ideas in a variety of ways ACSIS029

Year 2

Science Inquiry Skills

Pose and respond to questions, and make predictions about familiar objects and events ACSIS037

Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources ACSIS038

Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate ACSIS039

Use a range of methods to sort information, including drawings and provided tables ACSIS040

Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play ACSIS042

General Capabilities:

Literacy, Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability, Ethical understanding. Source: (ACARA, 2015)

Activity 6:
Can you make a plane fly?

One of the first occurrences of powered flights, and the best known, occurred in 1903. It lasted 12 seconds and the aeroplane flew almost 37 metres. The plane was invented, designed, built and flown by the Wright brothers.

Be challenged like **Orville and Wilbur Wright** and design and launch a plane.

You will need:

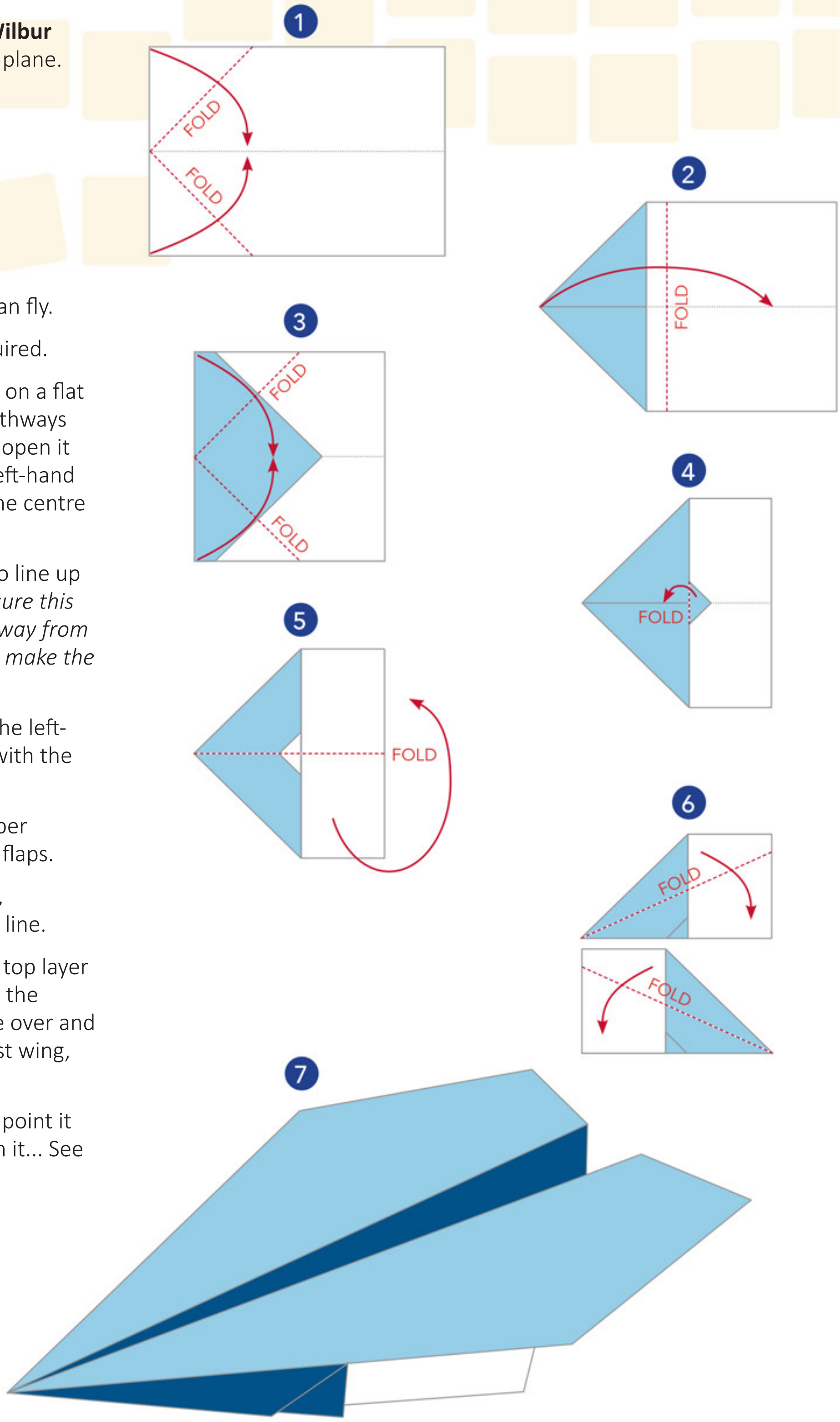
- Sheets of A4 paper
- Sticky tape

What to do:

- Design a paper plane that can fly.

Step-by-step instructions, if required.

1. Place the sheet of A4 paper on a flat surface and fold in half lengthways to make a centre line. Then open it up again. Fold each of the left-hand corners in, to line up with the centre line.
2. Fold the pointed end over to line up with the centre line. *Make sure this fold is about a centimeter away from the bottom of the flaps that make the point.*
3. Like in Step 1, fold each of the left-hand corners in, to line up with the centre line.
4. Fold the little triangle of paper sticking out over the pointy flaps.
5. Fold the whole piece in half, backwards along the centre line.
6. To make the wings, fold the top layer down on an angle similar to the diagram. Then flip the plane over and using the angle from the first wing, fold the second down.
7. Grab the base of the plane, point it slightly upwards, and launch it... See how far it can fly.



Activity 7:
Can you make something float or sink?

The person who first worked out the answer to why things float or sink was Greek mathematician ***Archimedes****. This was sometime in the third century BC.*

You will need:

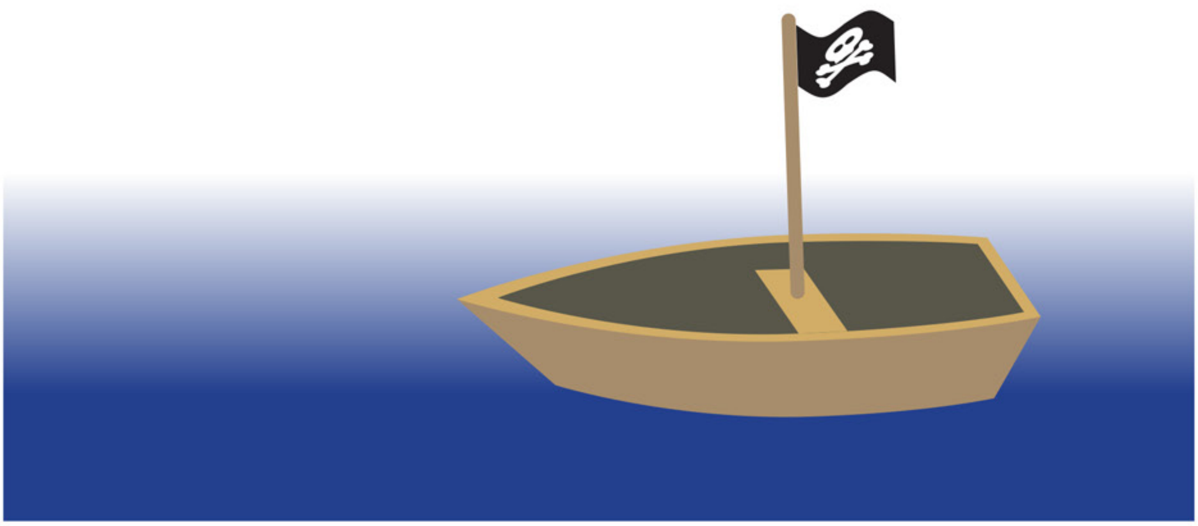
- Oranges
- A vegetable peeler
- A large container of water or a water trough or a bath
- A range of different items to test for floating or sinking. For example, an inflated balloon, cotton wool, shells, ice, paper, socks, a marble, a leaf, a bottle top etc.

What to do:

- Make predictions or hypotheses about which items might sink or float.
- Test which items sink or float by placing them in the water.
- Record your findings.
- Focus on the orange.
- Make predictions or hypotheses about whether the orange will float or sink.
- Test your hypotheses by placing the orange into the water.
- Record your findings.
- Peel the orange, being careful to remove most of the white pith too.
- Make predictions or hypotheses about whether the peeled orange will float or sink.
- Test your hypotheses by placing the peeled orange into the water.
- Record your findings.
- Next, consider the orange peel.
- Make predictions or hypotheses about whether the orange peel will float or sink.
- Test your hypotheses by dropping the peel into the water.
- Record your findings.

Concluding activity:

Discuss what's happened.



Activity 8: Game changers– honey bees

Overview: *Explain to the class that their task is to explore the world of honey bees and then design and produce a model of a honey bee. Students also use their model of a honey bee to spread the word about how vital bees are for the wellbeing of our food and environment.*

Background science for students: honey bees

The best-known honey bee is the western honey bee which has been domesticated for honey production and crop pollination. Honey bees represent only a small fraction of the roughly 20,000 known species of bees. Some other types of related bees produce and store honey, including the stingless honey bees. (Adapted from **Wikipedia**,2017)

A breakthrough discovery in beekeeping was made by a man called **Lorenzo Langstroth**. He discovered that bees would keep a 'bee-sized' pathway clear within a hive if it was between 6 and 8 mm wide. He named the discovery 'spazio di ape' (or 'bee space' in English). This discovery was important because it led to the development of hives with moveable frames of honeycomb. This allowed the beekeeper to remove honeycomb and honey without destroying the hive. It also enabled the beekeeper to start manipulating the colony, helping it develop and grow. This discovery is often cited as the start of modern beekeeping. (**Omlet,** 2017)

The essential question:

What happens when we understand how vital bees are for the wellbeing of our food and environment?

The scenario:

National Science Week is seeking schools to be involved in spreading the word about how vital bees are for the wellbeing of our food and environment.

Be a game changer like **Lorenzo Langstroth** and learn about the honey bee, what they produce and what they do to help plants grow.

What investigations can assist you in your mission? Might you investigate your school vegetable garden for flowers with the nectar that honey bees need? Might you invite a guest speaker from the industry to come and share information with you? Might you invite a local beekeeper to visit and share what is known about honey bees?

Your challenge is to design and produce a model of a honey bee and use it to spread the word about how vital bees are for the wellbeing of our food and environment. Are you up for the challenge?

Safety note: Identify students and other participants (such as accompanying parents or teachers) who have an allergic reaction to bee stings, and take measures as appropriate to avoid being stung.

A suggested learning process:

Define:

Share the essential question with the class and talk about honey bees and how vital bees are for the wellbeing of our food and environment.

Present the scenario, assign student pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Where possible, invite local beekeepers to visit the class and talk about bees, beekeeping, what bees look like, what they do (pollinate flowers and use nectar to make honey) and how they do it.

Locate where bees and flowers can be found in the school grounds or nearby garden. Talk about how bees use flowers for pollen and nectar, which, in turn is used to make honey.

View a range of videos about bees, collecting nectar and honey making:

All About Bees. An Interesting Picture Book for Kids on YouTube (3:07min)

Busy Bees on YouTube (3:59 min)

Bees on YouTube (3:05 min)

The Honey Files: A Bee's Life on YouTube (16:05 min)

Find out more about producing honey. View ABC Splash's video **Farming Bees. Bzzzzz** (7:34 min)

Use the ideas introduced by the guest speakers and/or videos as a springboard to help the students consider what bees look like, what they produce, what they need to collect in order to produce honey and how vital bees are for the wellbeing of our food and environment.

Talk about how bees have:

- a head with two eyes, one mouth, a tongue (proboscis) and two feelers;
- a thorax (middle section) with four wings and six legs; and
- an abdomen (the section at the rear) with a sting to defend itself and a pollen basket (stiff hairs on the back legs for carrying pollen).

Look for pictures or photos of bees and list their body parts and identify the features of each part.

Ask students to draw a honey bee and label the bee's head, thorax and abdomen.

Identify areas in and around the school and children's homes where bees and flowering plants are found that might contain nectar.

Introduce the word 'pollinate' and talk about how bees are pollinators.

Draw mind maps to record information known about bees.

Brainstorm ways the class could design and produce a model of a bee.

Set up teams of 'bee-watchers' to spot bees during play periods.

Take photos of bees at work e.g., collecting nectar from a flower, pollinating flowers, looking for nectar and pollen, pollinating crops, or approaching a bee hive.

Compare information that is collected with other bee-watchers.

Record information about the time of day bees are spotted, the number of bees seen, the weather on that day, and the season bees are seen.

Draw records showing the types of flowers that the bees are seen pollinating.

Talk about the range of pollen-bearing flowers in and around the school. Photograph these and create a scientific record. Display these around the classroom.

Dream:

In pairs or small groups, envision or dream about the many possible solutions to designing and making a model of a honey bee.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to include a model of a honey bee and it needs to be used to spread the word about how vital bees are for the wellbeing of our food and environment.

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in making their item.

Ask students to gather the materials, tools and equipment needed and then design and create the solution.

Invite a peer class group to the class to learn from the students about honey bees, what they look like, what they do and how vital bees are for the wellbeing of our food and environment.

Deliver:

In pairs or small groups, showcase the creations and associated messages.

Classes host a National Science Week Honey Bees Day and invite students, teachers and parents to discover what the class knows about honey bees and how vital bees are for the wellbeing of our food and environment.

Share photos and students' stories via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek. Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to reflect on their learning and draw something they learnt that was new.

Ask students to describe what worked well and not so well in their efforts to create a model of a honey bee and use it to spread the word about how vital bees are for the wellbeing of our food and environment.

Case studies

Australian researcher working to immunise honey bees, to protect them from varroa mite

Read about a game changer in Australia, **Dr. Emily Remnant** a research scientist from the University of Sydney and learn about her achievements in trying to protect honey bees.

Big Buzz... HSC students in NSW can study beekeeping in 2018.

Did you know that more than 65 percent of the food we eat depends on bees (i.e. pollination)?. Bees are the game changers in agriculture when you think about it. Find out about the new **Beekeeping school-based traineeships**.

Students act for native bees

Students at Ascham School in Sydney's east are taking action to help address the decline of native stingless bees. Applying the STEAM model of integrated learning across Science, Technology, Engineering, Arts and Mathematics, students will research, design and build suitable habitats for the bees using recycled products. They then plan to introduce and monitor a population of native bees on the school grounds.

Links to the Australian Curriculum

Technologies

Foundation, Year 1 and Year 2

Design and Technologies Processes and Production Skills

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

Generate, develop and record 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

Science

Foundation, Year 1 and Year 2

Science as a Human Endeavour—Nature and development of science

Science involves observing, asking questions about, and describing changes in, objects and events ACSHE013 ACSHE021 ACSHE034

Science as a Human Endeavour—Use and influence of science

People use science in their daily lives, including when caring for their environment and living things ACSHE022 ACSHE035

Foundation

Science Understanding—Biological sciences

Living things have basic needs, including food and water ACSSU002

Science Inquiry Skills

Respond to questions about familiar objects and events ACSIS014

Participate in guided investigations and make observations using the senses ACSIS011

Engage in discussions about observations and represent ideas ACSIS233

Share observations and ideas ACSIS012

Year 1

Science Understanding—Biological sciences

Living things have a variety of external features ACSSU017

Science Inquiry Skills

Respond to and pose questions, and make predictions about familiar objects and events ACSIS024

Participate in guided investigations to explore and answer questions ACSIS025

Use informal measurements to collect and record observations, using digital technologies as appropriate ACSIS026

Use a range of methods to sort information, including drawings and provided tables and through discussion, compare observations with predictions ACSIS027

Compare observations with those of others ACSIS213

Represent and communicate observations and ideas in a variety of ways ACSIS029

Year 2

Science Understanding—Biological sciences

Living things grow, change and have offspring similar to themselves ACSSU030

Science Inquiry Skills

Pose and respond to questions, and make predictions about familiar objects and events ACSIS037

Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources ACSIS038

Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate ACSIS039

Use a range of methods to sort information, including drawings and provided tables ACSIS040

Through discussion, compare observations with predictions ACSIS214

Compare observations with those of others ACSIS041

Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play ACSIS042

General Capabilities:

Literacy, Numeracy, ICT capabilities, Critical and creative thinking

Cross Curriculum Priority:

Sustainability OI. 2 and OI.7. Source: (ACARA, 2015)

Activity 9:

Can you draw and design a hotel for bees?

Families all over the world are making hotels for bees out of recycled materials. These hotels can be a nesting place for bees in summer and a hibernation place in winter.

Be challenged and use the image below to inspire you to draw or make a model of a bee hotel.

You will need:

- Recycled cardboard, plastic bottles, tree branches, rocks, twigs
- Bricks and shelving

What to do:

Draw and design a hotel for bees.

Case study

The Flow Beehive

Find out more about **Cedar and Stuart Anderson** who invented the **Flow Beehive** that allows the harvesting of honey without opening the bee hive.

Activity 10:

Can you build your own suspension bridge?

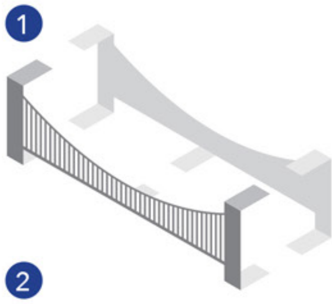
The earliest versions of suspension bridges were built by ***Thangtong Gyalpo****, a Tibetan saint and bridge builder from the 15th century. He built over 58 iron chain suspension bridges around Tibet and Bhutan and one of his bridges survived until 2004, when it was destroyed by a flood. Most of his bridges had chains as suspension cables while his early bridges used ropes from twisted willows or yak skins.*

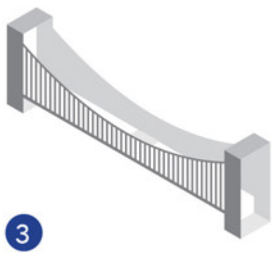
The first design of a suspension bridge that is similar to today's modern designs appeared in book *Machinae Novae* in 1595, which was written by Venetian polymath **Fausto Veranzio**. Source: **Suspension Bridge – From Earliest to Modern Design**

Be challenged like these architects, engineers and builders and build your own suspension bridge.

You will need:

- A print out of the model pieces below
- Light-weight cardboard (a large empty cereal packet is perfect)
- Glue
- Scissors
- A ball-point pen and ruler
- Tape

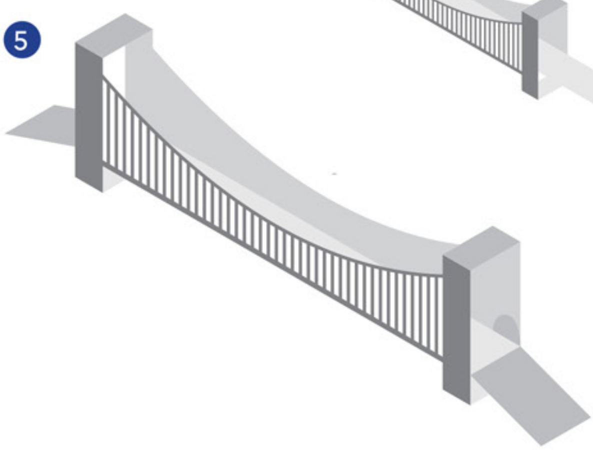


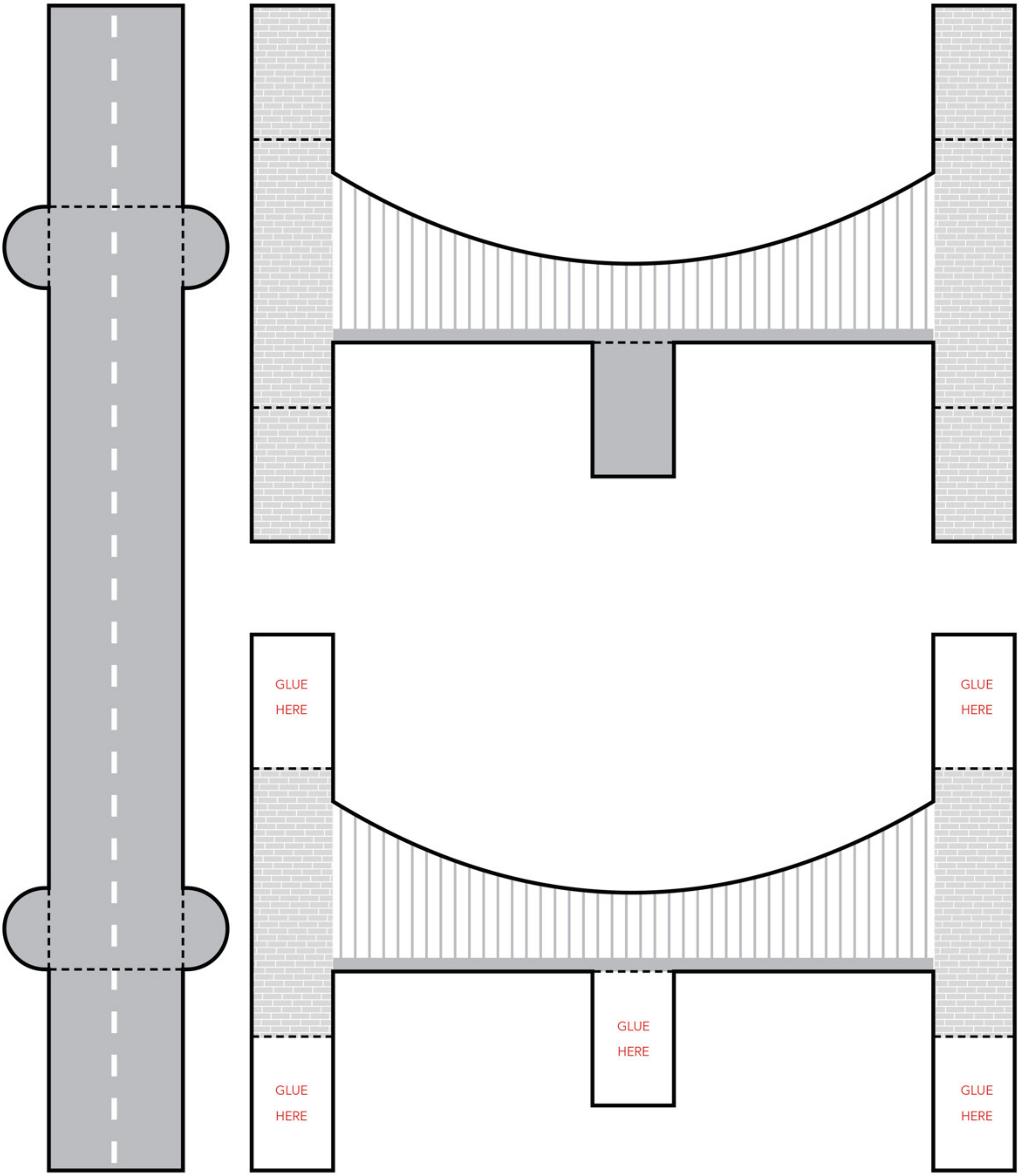


What to do:

- Glue a print out of the following page onto light-weight card. *Tip: It will be easier to cut out if you enlarge the print to fit an A3 page.*
- Cut out all the pieces by carefully cutting along the thick black lines ▬▬ .
- With the ball point pen and the ruler, draw over the dotted lines - - - . Pressing quite hard. This will make them easier to fold.

1. Fold all tabs on both bridge pieces so they are at right angles and carefully apply glue to the tabs indicated.
2. Line up both sides of the bridge and firmly push each of the pairs of tabs together.
3. Fold both ends of the road piece down slightly and fold up the rounded tabs vertically.
4. Apply glue to the outer side of the road tabs. Carefully slide the road piece into the bridge and when the road is positioned correctly press the tabs onto the inside of the bridge support towers.
5. Then you have built a suspension bridge.

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Early Childhood Fun Ideas for National Science Week

Read about it!

There are many stories about game changers and change makers in STEM. For example, read Pamela Allen's book **Mr Archimedes' Bath**, Peter Sis's book **Starry Messenger – Galileo Galilei**, Laurie Wallmark's book **Ada Byron Lovelace and the Thinking Machine**, Isabel Sanchez Vegara's book **Marie Curie (Little People Big Dreams)** or Jeanette Winter's book **The Watcher: Jane Goodall's Life with Chimps**.

Create it!

Art is a fun way to explore a new concept. Create a range of art and craft samples to celebrate the discoveries and inventions of game changers and change makers in STEM.

Act it out!

Make your own puppets and act out a puppet show about game changers and change makers in STEM.

Dress up and dance!

Make your own masks and costumes and create a dance about game changers and change makers in STEM.

Feel it!

Sensory play is an important part of learning. Create a 'Feely Bag' using a pillowcase and place a range of items inside it. Play Pass the Parcel and discover all that has been discovered by game changers and change makers in STEM.

Paste it!

Create collages about game changers and change makers in STEM.

Quiver it!

Download the app **Quiver App** and use cutting-edge colour technology and experience augmented reality colouring experiences. Note there is a one-time purchase price.

GAME CHANGERS & CHANGEMAKERS

For the

Primary Years of Schooling

Years 3–6

Getting started with **Sustainability** in **Schools**

It's time to get started with sustainability

Sustainability is a cross-curriculum priority within the Australian Curriculum. It's time to embed sustainability into your classroom, school and community.

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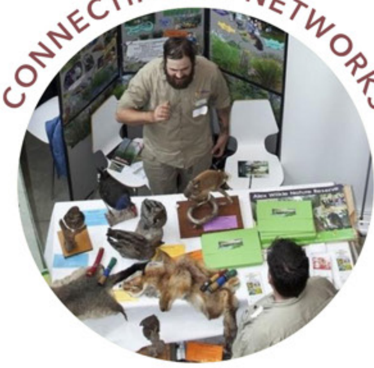

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aaee
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Activity 1: Think like a game changer!

Overview: *Explain to the class that they will be investigating how game changers like scientists investigate questions, make hypotheses, experiment, analyse and ask questions about what happened in an investigation, form ideas and make fascinating discoveries.*

Background science for students: What is the 'scientific method'?

Scientists have lots of questions about the world around us, and probably you do as well. One method that scientists use to answer questions is called the scientific method, which is the process of asking questions, hypothesising, experimenting, observing, analysing and asking questions about what happened in the experiment and reaching conclusions.

This is how it works. First, they try to predict what the answer to the question might be. This is called a hypothesis. They often base the hypothesis on existing knowledge, ideas and theories. Then sometimes scientists carry out experiments to see what will happen. They usually change one factor at a time to ensure they know what has made a difference. They use the results of the experiments to determine if their hypothesis was correct.

The essential question:

What happens when we understand how scientists investigate questions, make hypotheses, experiment, analyse and ask questions about what happened in an investigation, form ideas and make fascinating discoveries?

The scenario:

Brilliant ideas have driven science since its beginning and today, like long ago, science is sensational.

Thanks to science and scientists and the way that they think, we understand a lot about how everything works.

Your challenge is to think like a scientist and try a number of science activities: ask some scientific questions, hypothesise, experiment, analyse and ask questions about what happened in the experiment, form conclusions and ideas, and then make a paper slide video and describe what you have learned about science and its game changers. Your video needs to include: the name of the game changer; what they discovered, designed or invented; and explain your understanding of the science, technology or maths you choose to showcase.

A suggested learning process:

Define:

Capture students' interest and show the video **Science Rules** on YouTube (3:08 min). Listen to the song in the video and talk about and display the different areas of science mentioned in it. For example, geology, chemistry, biology, archaeology, astronomy and physics. Display these areas of science and scribe what students think they might be about. For example, geology is about rocks, chemistry is the science of materials and their reactions, physics is the study of matter and energy, and the way it moves and changes, biology is the science of living things, and astronomy is the science of things beyond the Earth, including the planets, moons and stars.

Pose the question: 'What happens when we understand how scientists investigate questions, make hypotheses, experiment, analyse and ask questions about what happened in an investigation, form ideas and make fascinating discoveries?'

Before any research is undertaken, ask students to tell the class what they intend to do. For example, '… these are the questions we are going to find out about'.

List questions on a wall chart as they arise.

Encourage and support students to investigate materials in the Maker Space, observe, experiment, classify, discuss, ask questions, record questions and findings, and reflect.

Ask students to articulate their understanding of the task/challenge through discussion and if appropriate a written (scribed) statement.

Discover:

Invite students to explore a Maker Space where they can explore a game changer or change maker in science, technology, engineering or maths and amazing scientific thinking.

For example:

Maker Space 1 can be titled 'Make an hypothesis'.

Information provided to students could read: 'Which of the following would NOT be an hypothesis? An hypothesis is a yet to be proven claim or theory about something.'

Add to the following questions and place them on the Maker Space table or screen.

- I predict that the balloon will bang when it is popped.
- I think that a boat will sink if it is too heavy.
- If I suck on a lolly for an hour, I predict that it will get smaller.
- The banana went all squishy and exploded everywhere when I stood on it.

Ask students to discuss each question, and discuss whether it is or isn't an hypothesis explaining their reasons.

Ask students to create their own hypothesis and record these at the Maker Space.

For example: Create a Hypothesis

What do you predict?

I hypothesise that…

Maker Space 2 can be titled 'Make a classification key'.

It can be set up with pictures of different plants, animals and minerals. Include: two-legged and four-legged animals, animals with whiskers, animals with spots, reptiles, mammals, marsupials, fish, birds, trees, flowers, grasses, ferns, fungi, shells, crustaceans, root vegetables, leafy vegetables, plus a paper clip, spoon, rocks, and a crystal. Add collections of bones, for example, lamb, fish or the bones of birds (including chicken).

Game changer information provided to students could read: 'In the 18th century, **Carl Linnaeus** published a system for classifying living things. In 1689, **Richard Waller**, in his efforts to index plants created the first Dichotomous Key. Scientists all over the world use the Dichotomous Key to name organisms.'

Ask the students working in pairs or small groups to hypothesise which objects are animals, minerals and plants. Then group and classify the artefacts in the Maker Space into living or non-living things.

Ask students to share and compare their classifications.

Invite students to justify their groupings and discuss ways in which classification can be useful.

Then, using only the pictures or models of the mammals, fish, reptiles, insects, spiders, amphibians and birds ask students to make their own 'key' identifying which are plants or animals.

Maker Space 3 can be titled 'Make a boat that floats'.

Game changer information provided to students could read: 'The person who first worked out the answer to why things float or sink was Greek mathematician **Archimedes**. This was sometime in the third century BC. He came up with the famous law of physics now known as Archimedes' Principle; which states that, when something is resting in or on water, it feels an upward (buoyant) force equal to the weight of the water that it pushes aside (or displaces).'

The Maker Space can be set up with a large bowl of water, several sheets of aluminium foil and lots of marbles.

Ask students to design and build a boat that won't sink or tip over.

Ask students to hypothesise which boat shape might be the more stable.

Invite students to place their boats into the bowl of water and test whether it will float or sink.

Ask students to add marbles to test buoyancy and to record their observations.

Maker Space 4 can be titled 'Make a line of symmetry'.

The Maker Space can be set up with paints, paper, rulers, pencils, a mirror, a cut-out of a triangle, a cut-out of a circle, and a cut-out of a square as well as images of animals that have mirror symmetry, for example: a butterfly, crab, or grasshopper.

Game changer information provided to students could read: 'Scientists like **Pythagoras** and **Leonardo da Vinci** and a female mathematician named **Amalie Emmy Noether**, used symmetries.'

Introduce the idea of symmetry by asking students to look at themselves in a mirror and see how their left half and right half roughly match.

Talk about how, if we could fold ourselves in half, our right half would roughly match our left half. Ask students to draw an imaginary line dividing their body in half vertically through their nose and belly button, and explore symmetry.

In pairs, ask students to explore their left and right hands. Do they roughly match?

Ask students to hypothesise what things might be symmetrical.

In pairs, explore symmetrical shapes. Ask pairs of students to investigate which shapes repeat themselves when folded.

Alternatively, using a piece of A4 paper, ask students to fold the piece of paper in half and place a blob of paint on one side of the paper, and then ask them to fold it. Does it create a symmetrical design?

Pose the question: 'What happens when we are curious like scientists and investigate questions, and make fascinating discoveries?'

Maker Space 5 can be titled 'Make the tallest tower'.

The Maker Space can be set up with marshmallows, a strip of masking tape and lots of pieces of spaghetti.

Instructions provided to students could read: '**Gustave Eiffel**, **Emile Nouguier** and **Maurice Koechlin** had the idea for a very tall tower in June 1884. They designed and built the Eiffel Tower in Paris. The tower has 72 names of French engineers, scientists and mathematicians who contributed to its construction. **Sophie Germain**, a female mathematician who did early work on electricity, was also involved in the construction of the tower.'

Ask students to hypothesise how they might build their tower.

Ask students to use the spaghetti, tape and marshmallows to build their tallest tower.

Dream:

Ask students to imagine the steps involved in designing a paper slide video.

Remind students that their video needs to include: the name of the game changer; and what they discovered, designed or invented; and also explain the students' understanding of the science, technology or maths they choose to showcase.

Challenge students to think about the materials, tools, and equipment they will need to design their individual work samples.

Design:

Ask students to research how to make a paper slide video. Play the video **How to Make a Paper Slide Video** on YouTube (2:22 min).

Ask students to design a paper slide video's script and decide on its title.

Ask students to draft their text and plan what illustrations will complement the text.

Invite a peer class group to the class and ask students to explain their work sample's concepts to this audience and seek feedback on their ideas.

Deliver:

Ask students to create a paper slide video that includes the name of the game changer, and what they discovered, designed or invented and that also explains the students' understanding of the science, technology or maths they choose to showcase.

Schedule a cinema or movie afternoon and invite parents and the school leadership team to come and learn about game changers in science, engineering and mathematics where students share their paper slide videos.

Share photos and students' work samples via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek. Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to recall what fascinating game changers they discovered. Discuss their important discoveries.

Talk about what they might still like to discover and whether there is anything they would like to research or delve into more deeply.

Ask students to describe their favourite part of making a paper slide video and sharing it with others as part of National Science Week and sharing it with others.

Case study

Check out the amazing ideas that have led to breakthrough products developed by kids as part of the **'Little Big Idea'** competition.

Links to the Australian Curriculum

Science

Year 3 and Year 4

Science Understanding—Biological sciences

Living things can be grouped on the basis of observable features and can be distinguished from non-living things ACSSU044

Science Understanding—Chemical sciences

Natural and processed materials have a range of physical properties that can influence their use ACSSU074

Science Understanding—Physical sciences

Forces can be exerted by one object on another through direct contact or from a distance ACSSU076

Science as a Human Endeavour—Nature and development of science

Science involves making predictions and describing patterns and relationships ACSHE050 ACSHE061

Science as a Human Endeavour—Use and influence of science

Science knowledge helps people to understand the effect of their actions ACSHE051 ACSHE062

Science Inquiry Skills

With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS053 ACSIS064

Represent and communicate observations, ideas and findings using formal and informal representations ACSIS060 ACSIS071

Technologies

Year 3 and Year 4

Design and Technologies Processes and Production Skills

Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques ACTDEP015

Select and use materials, components, tools and equipment using safe work practices to make designed solutions ACTDEP016

Evaluate design ideas, processes and solutions based on criteria for success developed with guidance and including care for the environment ACTDEP017

Plan a sequence of production steps when making designed solutions individually and collaboratively ACTDEP018

Mathematics

Year 3 and Year 4

Measurement and Geometry

Create symmetrical patterns, pictures and shapes with and without digital technologies ACMMG091

General Capabilities:

Literacy, Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability, Ethical understanding. Source: (ACARA, 2015)

Activity 2:
Weird and wonderful creatures and robots

The science fiction story Frankenstein *was created by* **Mary Shelley** *in January 1818.*

Her creature was put together by Dr Victor Frankenstein using human parts. He then infused it with the essence of life with an electric spark.

Since that time, many authors have created creatures that we visualise in stories, see in movies and play with in games.

The first robot wasn't built in a workshop or a lab. Just like in the science fiction story *Frankenstein*, the first robot was a character in a play. That play was written in 1921 by **Karel Capek**. In 1979, **Ruzena Bajcsy** helped create robots that could sense and respond to their environment.

What to do

Be challenged like Mary Shelley and Karel Capek and design and make your own creature or robot that helps do your science homework.

What might it need to know? How might it learn this? Will it be programmed?

Share your creature or robot as part of National Science Week.

Case studies

Find out about a **10 year old girl who is too sick to go to school and uses a robot** to make sure she never misses a class.

Read about **Maitland Lutheran School** in South Australia that has programmed a robot to learn an indigenous language.

Activity 3: May the force be with you

Overview: *Explain to the class that they will be exploring the concept of force. Their task is to use science to show exactly how force and gravity work.*

Background science for students: Laws of the universe.

Have you ever wondered why everything in the universe moves? If you have ever asked questions like this, then you were thinking like **Isaac Newton.** During the period 1663 to 1713, Isaac Newton's scientific aim was to write down scientific laws about how everything in the universe moves and how everything is connected.

Isaac Newton came up with new theories of movement and gravity and checked whether he was correct using a new kind of mathematics that he had invented.

His results explained how the planets move and why the moon orbits, or travels round the Earth. He discovered the law of gravity.

The essential question:

What happens when we understand how forces make things move?

The scenario:

National Science Week is looking for students to discover what make things move.

What kind of scientist will you be, and what questions will you pose, and what solutions will you design to test your ideas?

What science investigations can assist you in your mission?

Your challenge is to use **Isaac Newton's** ideas and your own thinking to help others understand what makes things move, and what gravity is and demonstrate this to other classes during National Science Week. Are you up for the challenge?

A suggested learning process:

Define:

Share the essential question and scenario with the class and talk about 'forces'.

Ask students the following question: Which of these is not a force?

- A push
- A pull
- A rock
- Gravity

Talk about how forces change the way things move.

Ask students the following question: 'If you push a toy car from behind what will happen?' and elicit the correct response from the list below.

- It will move forward.
- It will move backwards.
- It will stay still.

Ask the following true or false question: 'If an object is pushed or pulled does it have to move?'

- True
- False

And, 'Does gravity pull on things to make them fall down or to keep them down?'

- True
- False

Discuss how people are constantly moving things.

Talk about how nature is constantly exerting forces. Air can push, water can push, and gravity is always pulling things towards the centre of the Earth. We observe the effects when moisture falls from the sky, as rain, under the force of gravity.

Present the scenario again, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Explore forces by placing a bottle on a table. Talk about gravity being the force that is applied to the water bottle.

Ask students to hypothesise what will happen if they put the same water bottle on tissue paper.

In groups, ask four students to hold the corners of a piece of tissue paper 10 cm above a table and have a fifth student place the water bottle onto the tissue paper.

Explain that the force on the bottle is gravity and that the force applied to the tissue paper is a lateral force, as it is being pulled from all four corners. Again, highlight how the density of the tissue paper cannot withstand the weight of the bottle and the force of gravity, so the bottle falls through the tissue paper.

Ask students to draw a diagram of the forces in their learning logs.

Ask students to hypothesise what will happen if we put the same water bottle on a sheet of A4 photocopy paper.

In groups, ask four students to hold the corners of the sheet of photocopy paper 10 cm above the table and ask a fifth student to place the water bottle on the sheet of photocopy paper.

Explain that the force on the bottle is gravity and that photocopy paper may or may not exert sufficient upward force to balance gravity, in which case, the bottle may fall through or stay on the sheet of photocopy paper. Talk about the strength of the fibres in the sheet of paper and how this affects what might happened.

Encourage students to draw a diagram of forces in their learning logs.

Challenge students to use an inquiry process to get a straw to move along a piece of string (without directly pushing it with their hand) using just a balloon, string and tape.

Connect that inquiry to prior knowledge gained regarding forces. For example: Thread one end of the string through the straw. Tie each end of the string between two solid supports such as a chair, table leg or doorknob, making sure it is strung tightly. Blow up the balloon but do not tie it. Holding the opening of the balloon closed with your fingers, tape one side of the balloon to the straw so that it hangs horizontally below the string. Get ready for launch and let the end of the balloon go. Watch as the air escapes and sends your balloon rocketing across the string track.

Talk about gravity.

Explain how the Earth tries to pull everything down towards its centre and how this pull is called the force of gravity (the invisible force).

Explain how, if you lift things up, you have to pull against gravity (weight).

Talk about how, if you drop a pencil, gravity pulls it down to Earth.

Challenge students to experiment with magnets and force and discover more about gravity. Set up an Explorer Space with the following:

- a small dowel or stick
- string
- paper clips

Encourage students to explore gravity by tying the paper clips onto pieces of string and then tie each piece of string onto the small piece of dowel or stick.

Ask students to predict what they might see happen.

Then, ask students to lift up the dowel rod or stick so the paper clips hang from the string.

Ask the following questions:

- In which direction do the paper clips point?
- What happens if you tilt the stick?

Talk about how the paper clips are being pulled down toward the Earth by gravity, but they can't fall because the string is holding them in the air. Also point out that, no matter which way we tilt the dowel or stick, the paper clips were still being pulled straight toward the Earth by gravity.

Challenge students to think of other ways they might demonstrate what gravity is.

Safety note: Small magnets are choking hazards, and magnet ingestions pose a serious threat to the health of students. Students should be supervised when exploring with magnets.

Dream:

In pairs or small groups, envision or dream about the many possible solutions to designing and making a demonstration to show what makes things move and what gravity is.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to demonstrate to others what makes things move and what gravity is.

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in making their demonstration.

Ask students to gather the materials, tools and equipment needed and then design and create the solution.

Invite a peer class group to the class to hear from students about what makes things move and what gravity is.

Deliver:

In pairs or small groups, showcase the creations and associated messages.

Classes host a National Science Week Day and invite students, teachers and parents to discover what the class knows about what makes things move and what gravity is.

Share photos and students' stories via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of children in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek. Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to reflect on their learning and draw something they learnt that was new.

Ask students to describe what worked well and not so well in their efforts to demonstrate what makes things move and what gravity is.

Links to the Australian Curriculum

Science

Year 3 and 4

Science Understanding—Physical sciences

Forces can be exerted by one object on another through direct contact or from a distance ACSSU076

Science as a Human Endeavour—Nature and development of science

Science involves making predictions and describing patterns and relationships ACSHE050 ACSHE061

Science as a Human Endeavour—Use and influence of science

Science knowledge helps people to understand the effect of their actions ACSHE051 ACSHE062

Science Inquiry Skills

With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS053 ACSIS064

Represent and communicate observations, ideas and findings using formal and informal representations ACSIS060 ACSIS071

General Capabilities:

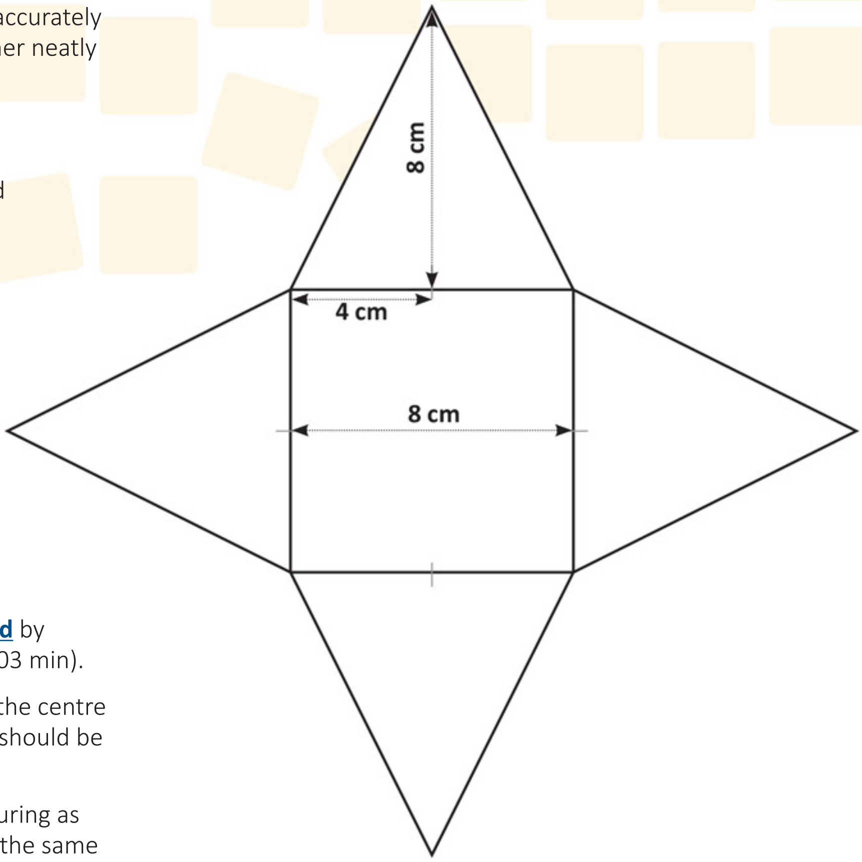
Literacy, Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability, Ethical understanding. Source: (ACARA, 2015)

Activity 4:
Build a pyramid

The Great Pyramid in Egypt is very old and is made of 2.3 million blocks of stone and weighs nearly six million tonnes. It has four sides, each 230.4 metres long.

Your challenge is to build your own pyramid, but maybe not quite that size.

You will need to measure very accurately so that all four sides join together neatly at the top.



You will need:

- A piece of A3 paper or card
- A ruler
- A pencil
- Scissors
- Colouring pens
- Tape
- Glue
- Some sand

What to do:

Explore **how to make a Pyramid** by viewing a video on (YouTube 4:03 min).

Measure and draw a square in the centre of the paper or card. Each side should be 8 cm.

Be very careful with your measuring as all the sides need to be exactly the same length.

Measure and mark halfway along one side (4 cm). Place your ruler on the mark and at right angles to the line. From this point, draw an 8 cm line away from the mark.

Then, draw two lines from the tip of the 8 cm line back to the corners of the square, making a triangle.

Repeat this on the other three sides.

Colour the pyramid, cut the shape out and fold the triangles upwards from the base. If you have measured accurately they will all meet at the top.

Tape the triangles together, so that the pyramid stays in shape.

Cover your pyramid in glue and sprinkle sand over it.

Activity 5: Let's get preserving

Overview: *Explain to the class that their task will be to explore preserving methods used in modern and traditional societies and then design and make a solution for preserving something grown and produced at school or home.*

Background science for students: Preserving

Knowing how to preserve food has been essential throughout our history as humans. Consider that before refrigeration—which was originally devised in the 18th century, but was not perfected and widespread until the 20th century—most people had to make do without refrigeration or freezing.

In 1795, **Nicholas Appert** began experimenting with ways to preserve foodstuffs, succeeding with soups, vegetables, juices, dairy products, jellies, jams, and syrups.

Many of his techniques are still in place today and are used for preserving produce.

There are many ways that food can be preserved. You can make your own preserves by bottling, pickling, drying, fermenting, salting, freezing, making bread and cooking.

The essential question:

What happens when we understand preserving methods used in modern and traditional societies?

The scenario:

Families all over the world have handed down traditional recipes. Some are handed down from mother to daughter or from father to son. Your challenge is to investigate a collection of preserving methods and recipes and then illustrate the steps involved in preserving your chosen food in a labelled drawing supported with a procedure on how to preserve something grown and produced at school or at home. Then contribute their recipe and the steps involved in preserving a food type to a book with the title *School Family Cook Book* for a class fundraiser.

A suggested learning process:

Define:

Share the essential question with the class and talk about 'preserving methods' and how they have been used by different cultures over time to make different food types.

Brainstorm known ways that foods may have been preserved by people and cultural groups over time.

Present the scenario, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Ask students to draw something they think of when they hear the phrase 'preserved food'.

Ask questions to establish students' prior understandings about technologies that are used to preserve different foods.

For example:

- What technologies and equipment might be used to grind coffee beans, peppercorns, cumin seeds, wheat or grains into finer particles?
- What technologies and equipment might be used to preserve fresh fruits like peaches, apricots, cherries and pears?
- What technologies and equipment might be used to produce frozen vegetables?
- What technologies and equipment might be used to make jam?
- What technologies and equipment might be used to dry herbs?
- What technologies and equipment might be used to de-husk wheat?
- What sort of preserved produce does someone you know produce?
- What sort of preserved product might you design from something grown at school or at home?

Discover:

Capture students' interest and share a variety of fresh, processed, canned, pickled, frozen, dried, pasteurised, powdered and freeze-dried food types.

For example, fresh fruit and vegetables, eggs, milk, bread, dried herbs, peppercorns, frozen vegetables, a jar of jam, powdered milk, freeze-dried coffee, rock salt, dried fruit, processed smallgoods, a packet of sugar, a can of fish, dried meat like beef jerky, pasteurised milk, a packet of rice or lentils, pickled onions or gherkins and processed cheese.

Talk about the different foods and find out what students might know about how these foods were produced and the technologies used to make them. Ask questions like:

- What is the name of the food?
- How might it have been prepared?
- What technologies, tools and equipment might be required to prepare it?

Talk with the students about the range of technologies, tools or equipment they think might have been used to produce some of the foods introduced in the earlier activity.

Invite parents, grandparents and carers to visit the class and bring along an example of, or recipe for, a food they have preserved. Create a class display of the preserved foods and recipes.

Ask students to discover and list the types of preserved foods they can find at home.

View a video and find out more about **how you can preserve foods like cherry tomatoes** in jars on YouTube (1:19 min).

Invite students to think about a food that they could preserve that is grown at school or at home.

Ask students to research and investigate the methods and technologies used for preserving their chosen food grown at school or home and to record ideas for their design ideas.

Ask students to communicate their ideas by drawing and writing a description of what they might preserve and how they might preserve it.

Talk about procedural writing and practise writing a procedure for preserving olives.

For example:

Preserving olives

1. Always use fresh and clean olives.
2. Make sure all tools are clean.
3. Place olives in a plastic bucket.
4. In a separate bucket, measure and add 1 litre of cold water and half a cup of salt.
5. Pour the salty water into a saucepan and, with adult help, bring it to the boil.
6. Remove the salty water from the heat.
7. Allow the salty water to cool for 10 minutes.
8. Place the olives in clean glass jars.
9. With adult help, pour the warm salty water over the olives in the jars.
10. Seal immediately.

Dream:

In pairs or small groups, envision or dream about the many possible solutions to designing and making a labelled drawing and writing a procedure about how to preserve a product that is grown at school or at home?

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to include a labelled drawing and a procedure about how to preserve a product that is grown at school or at home, and that it needs to be used in a *School Family Cook Book* for a class fundraiser.

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in making their items.

Ask students to gather the materials, tools and equipment needed to create their solution.

Ask students to illustrate the steps involved in preserving their chosen food type. Remind them that they need to communicate their design ideas and instructions with labelled drawings.

- Ask students to write a procedure of how to use the designed solution. They should evaluate their design, and suggest improvements where necessary, giving reasons.
- Students use their labelled drawing and procedure in a *School Family Cook Book* to spread the word about how they can use preserving methods.
- Invite a peer class group to the class to hear from the students about preserving food.

Deliver:

In pairs or small groups, showcase the creations and associated messages.

Classes host a Preserving the Year 3/4 Way Day and invite students, teachers and parents to discover what the class knows about preserving methods used in modern and traditional societies.

Debrief:

Ask students to reflect on their learning and draw something they learnt that was new.

Ask students to describe what worked well and not so well in their efforts to use preserving methods to preserve a product that was grown at school or at home, and then used in the *'School Family Cook Book'*.

Links to the Australian Curriculum

Technologies

Year 3 and 4

Design and Technologies Knowledge and Understanding

Investigate food and fibre production and food technologies used in modern and traditional societies ACTDEK012

Design and Technologies Processes and Production Skills

Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques ACTDEP015

Select and use materials, components, tools and equipment using safe work practices to make designed solutions ACTDEP016

Evaluate design ideas, processes and solutions based on criteria for success developed with guidance and including care for the environment ACTDEP017

Plan a sequence of production steps when making designed solutions individually and collaboratively ACTDEP018

Science

Year 3 and 4

Science as a Human Endeavour—Nature and development of science

Science involves making predictions and describing patterns and relationships ACSHE050 ACSHE061

Science as a Human Endeavour—Use and influence of science

Science knowledge helps people to understand the effect of their actions ACSHE051

General Capabilities:

Literacy, Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability. Source: (ACARA, 2015)

Activity 6:

Make your own reef animal and watch it move!

Game changers like ***Ron and Valerie Taylor****,* ***Ben Cropp*** *and* ***Sir David Attenborough*** *have been involved in investigating marine life for many years. Their underwater photography and scientific investigations have led us to know so much more about Australia's ocean reefs.*

In and around the marine waters of Australia's reefs, there are well over 10,000 species of animals and most are unique to Australia.

Select a species of reef animal that can jump out of the water.

Did you know that whales, dolphins, barracuda and sharks all can jump? So can seals.

Your task is to select a reef animal and make a model of it using pneumatics or hydraulics to create a jumping movement.

You will need:

- Thin cardboard (reef animal)
- Thick cardboard (base)
- Pencils, paints, felt-tipped pens
- Syringes
- 3 mm plastic tubing
- Masking tape and scissors

What to do:

Investigate:

- Using air and water, experiment with syringes and tubing.
- Research reef animals to find out what types are found in the waters of Australia's reefs.

Devise solutions:

- Draw a selection of designs for your reef animal.
- Work out how the syringes and/or tubing could be placed to create a jumping movement.
- Create a labelled drawing of your selected design.

Produce:

- Cut out your reef animal and paint or colour it.
- Place it on a base and arrange the syringes and tubing.
- Label the model with the species name of your reef animal.
- Share it as part of National Science Week.

Evaluate:

Does the reef animal look like the species it represents?

Does the jumping action work?

Does the jumping action work repeatedly?

Do you need to modify your design?

Activity 7:

Where art meets science

Listen to a game-changing song ***I Am The Earth*** *on YouTube (3:56 min) that inspired the graphics you can see to communicate the song's science topics. These graphics were created by students in the Marryatville Primary School Computer Group in Adelaide, South Australia.*

Be inspired and brainstorm all the science understandings the song and graphics convey. For example; life, life cycles, living things, renewable energies, weather and flight.

Your challenge is to design an artwork that communicates one of the following themes:

- Change makers in nature
- Game changers in towns
- Change makers in parks
- Game changers in space

Picture yourself as change makers and game changers within the context of the four themes. Depict yourself being actively engaged at the present time in observing and interacting with the environments, and/or imagine yourself in the future in certain roles e.g., marine biologist, park ranger, urban designer and astronaut.

Does the school have a 3D printer you might utilise?

Can you use digital technologies in your artwork? Will it be interactive?

Break new ground and create an artwork in which art and science, technology and culture are expressed.

Be inspired by **Leonardo da Vinci's** famous words: "**everything connects**".

Have fun and explore how you can use science, technology, engineering, mathematics and art to create a piece for a Science Week Exhibition that visitors of all ages can be invited to enter and explore.

Activity 8: Engineering Academy

Overview: *Explain to the class that their task is to learn from the best architects and engineers and design a bridge.*

Background science for students: Architects and engineers

Architects, engineers and builders do an amazing job designing and building homes, schools, shops, towers, bridges, offices, cinemas, libraries, fire stations, car parks, train stations, etc.

Architects, engineers and builders use science and maths to develop solutions to problems.

Did you know that there are many types of engineers?

- Chemical engineers discover and manufacture plastics, paints, fuels, fibres, medicines, fertilisers and paper.
- Civil engineers oversee the construction of buildings and structures.
- Electrical engineers develop the electrical parts of most things we use.
- Mechanical engineers design and make all sorts of equipment.
- Bio-medical engineers make artificial legs, joints and heart valves for people.
- Agricultural and industrial engineers design processes for making plants into all kinds of foods.

Architects, engineers and builders use a design process. It helps them stay on track when developing a building or a solution to a problem.

The essential question:

What happens when we understand how architects and engineers design and produce bridges?

The scenario:

As an architect or engineer, you need to know how to design and build bridges that are useful, safe and strong.

Bridges have to be designed carefully because they need to withstand heavy vehicles passing over them every day. They also need to be able to withstand windy weather.

Imagine you are an expert architect, engineer or builder and design and build your own bridge that can support a toy car.

What investigations can assist you develop your architect and engineering skills?

A suggested learning process:

Define:

Share the essential question and scenario with the class and talk about bridges.

Talk about the purposes of bridges and how they need to be strong to withstand gale force winds, hurricanes and cyclones.

Discuss their need to withstand carrying heavy vehicles, lots of people and sometimes trains.

Talk about how the work of an architect and engineer always begins with a 'brief'. Explain how this is a set of instructions written by the person who will own, or is paying for, the bridge.

Present the scenario again, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Locate where bridges can be found in the local area. Talk about what they are used for and the types of people who designed and built them.

Ask students to bring toy bridges to class and investigate their shapes and properties.

As a class, talk about Australia's famous Sydney Harbour Bridge. Use Google Images to source photos of the bridge.

Ask students to look at its shape and features and describe what they see. (It has two towers and an arch. It uses steel beams suspended from the steel arch to hold up the road.)

Discuss how the Sydney Harbour Bridge is an arch bridge.

Talk about what the Sydney Harbour Bridge is made from (steel, concrete and granite).

Talk about how the Sydney Harbour Bridge was built by a company called **Dorman Long** and a consulting engineer, named **Sir Ralph Freeman** who designed it. Explain that it took 1,400 people eight years to build.

Introduce and talk about Hobart's Tasman Bridge. Use Google Images to source photos of the bridge.

Ask students to compare the shape and features of the two bridges.

Discuss what materials were used to construct the Tasman Bridge.

Explain to students that the Tasman Bridge is a beam bridge that is supported at each end by columns and beams.

Investigate suspension bridges in Australia. They include the Walter Taylor Bridge and Kangaroo Point Bridge in Brisbane, the Jim Stynes Bridge in Melbourne and the Hampden Bridge in Kangaroo Valley in New South Wales.

Use Google Images to source photos of the bridges.

Talk about how suspension bridges support the weight of the road with vertical cables suspended from other cables running between the towers.

Ask students to compare the shape and features of the three types of bridges.

Discuss what each suspension bridge is constructed from.

Explain that there are many cantilever bridges in Australian. These bridges are built with sections that are only held up on one side, like a diving board.

Use these ideas to help the students consider ways they can design and produce their own bridge.

Ask students to consider manipulating materials, testing ideas, and accessing information sources to use in the later phases of their designs.

Talk about using either high-tech solutions like Minecraft to design a bridge; low-tech solutions like Lego® or no-tech solutions like newspaper, cardboard, pipe cleaners, string, paper clips, straws, masking tape, glue and tape.

Dream:

In pairs or small groups, envision or dream about the many possible design solutions to build a bridge that can hold a toy car.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to withstand the weight of a toy car.

Design:

Invite students, in pairs or small groups, to begin drafting their designs for their solutions.

Ask students to draft the steps involved in designing and making a model of their bridge that can hold a toy car.

Ask students to gather the materials, tools and equipment needed and then design and build the solution.

Invite a peer class group to the class to hear from the architects and engineers in the class describing the type of bridge they designed and built and also demonstrate how it can hold a toy car.

Deliver:

In pairs or small groups, showcase the bridge creations and associated messages explaining the type of bridge they designed and built and demonstrating how it can hold a toy car.

Host a Game Changers Day as part of National Science Week and invite students, teachers and parents to discover what they can do as architects and engineers.

Debrief:

Ask students to reflect on their learning and draw something they learnt that was new.

Ask students to describe what worked well and not so well in their efforts to design and build a bridge that can hold a toy car.

Links to the Australian Curriculum

Science

Year 3 and Year 4

Science as a Human Endeavour—Nature and development of science

Science involves making predictions and describing patterns and relationships ACSHE050 ACSHE061

Science as a Human Endeavour—Use and influence of science

Science knowledge helps people to understand the effect of their actions ACSHE051 ACSHE062

Technologies

Year 3 and Year 4

Design and Technologies Knowledge and Understanding

Recognise the role of people in design and technologies occupations and explore factors, including sustainability, that impact on the design of products, services and environments to meet community needs ACTDEK010

Investigate how forces and the properties of materials affect the behaviour of a product or system ACTDEK011

Investigate the suitability of materials, systems, components, tools and equipment for a range of purposes ACTDEK013

Design and Technologies Processes and Production Skills

Generate, develop, and communicate design ideas and decisions using appropriate technical terms and graphical representation techniques ACTDEP015

Select and use materials, components, tools and equipment using safe work practices to make designed solutions ACTDEP016

Evaluate design ideas, processes and solutions based on criteria for success developed with guidance and including care for the environment ACTDEP017

Plan a sequence of production steps when making designed solutions individually and collaboratively ACTDEP018

General Capabilities:

Literacy, Numeracy, ICT capabilities, Critical and creative thinking, Personal and social capability. Source: (ACARA, 2015)

Activity 9:
Watch cells at work!

You probably think it's quite obvious that your brother or sister look like your parents. But why is this? Why do we sometimes look more like one parent than another?

The answers to these questions lie deep in our cells and cells are the building blocks from which all living things are made.

We are built from many different types of cells and each cell type has a job to do. Bone cells provide our body's framework. Muscle cells help us move. Red and white blood cells are found in our blood and it is the white blood cells that destroy bacteria and viruses when we are sick.

Cells are really small and they were only discovered after the microscope was invented.

It was **Antonie van Leeuwenhoek** who made hundreds of powerful glass lenses that magnified our view of things. He was the first person to use a microscope and see microorganisms... and it was **Robert Hooke** who first saw cells under a microscope.

Investigate:

Discover how everything is made of cells.

You will need:

- Two glasses
- Four tablespoons of salt
- One carrot, cut in half
- One cup of warm water
- A marker pen

What to do:

- Half fill two glasses with warm water. Label them '**Glass 1**' and '**Glass 2**'. Stir two tablespoons of salt into **Glass 1**.
- Put half a carrot in each glass, cut end down. Leave overnight.
- Observe what you can see.
- Locate what you predict may be 'cells'.

What has happened?

In **Glass 1**, the carrot cells have tried to change the salinity (saltiness) of the water inside the carrot to the salinity of the water in the glass.

In **Glass 2**, the water has flowed into the carrot's cells, reducing their salinity making them plump and swollen.

In **Glass 1**, water from the carrot's cells has flowed out; making the cells collapse and therefore the carrot has shrivelled.

Activity 1: Marine debris and Australian reefs

***Overview:** Explain to the class that their task is to show their support for Australian reefs and inform others at the same time, by creating a poster and brochure for improved awareness about marine debris issues affecting them.*

Background science for students: Reef biodiversity

Biodiversity or biological diversity is the variety of all forms of life—the different plants, animals and microorganisms, the genes they contain and the ecosystems of which they form a part.

Australian reefs are recognised worldwide for their unique habitats and biological diversity. They provide homes and food for thousands of different species, and they are a learning ground for initiating the development of understandings and values about reefs and the need to use all reefs wisely, to protect the animals and habitats that live there and to protect our future enjoyment of them.

The Great Barrier Reef and Great Southern Reef

Did you know that the Great Barrier Reef provides a home to many unique species, 40 of which are listed as rare or threatened by the World Conservation Union (WCU)?

The Great Barrier Reef stretches for more than 2,000 km along the northeast coast of Australia. Comprising more than 2,900 reefs, some 940 islands and surrounding waters, the Great Barrier Reef is the largest natural feature on the Earth.

When considering the Great Barrier Reef (GBR), most people think only of coral reefs, but in fact, 94 percent of the GBR is made up of other communities such as sponge gardens, mangroves and seagrass beds. It is this unique and rich biodiversity that is worthy of protection.

The Great Southern Reef

The Great Southern Reef covers 70,000 square kilometres from Perth to Sydney via South Australia and Tasmania. This reef is uniquely biodiverse with between 30 and 80 percent of its species found only there. It is home to kelp forests, sea lions, giant cuttlefish and sea dragons.

Life on both the Great Barrier Reef and Great Southern Reef is a complex web of interactions, which connects millions of species together to sustain life—including human life.

The essential question:

What is the best way to get people thinking about finding solutions to the marine debris issues Australian reefs face?

The scenario:

"Bio" means life, as in biology, the science of life. Diversity means the variety of life.

Your science communications team has been approached by scientists and divers who want you to create a blog, poster and brochure designed to bring awareness to the way local people can better protect the marine wildlife that lives within the waters of Australian reefs by reducing the amount of marine debris that pollutes waterways and oceans.

In your designs, use powerful images and write 'action statements' and suggestions for what can be done to address these concerns.

Inspire people to work together by informing your community about the best ways to reduce the amount of marine debris that is washed or blown from the land into the sea, abandoned or lost by recreational and commercial fishers, and disposed of or lost by ships at sea.

A suggested learning process:

Define:

Share the essential question with the class and talk about the problem that needs to be addressed.

Present the scenario, assign teams if appropriate, and ask students to define the task they have been set.

Discover:

Using the video **Australia's Great Southern Reef Ocean Imaging** (1:05 min), discover the amazing biodiversity within its waters.

Discover the biodiversity of the **Great Barrier Reef** on YouTube (4:06 min).

Discover information about how marine debris is affecting Australian reefs.

View the video **Don't let your litter bug our reef** on the Great Barrier Reef Marine Park Authority website and then read the webpage for further information.

Read about **Sir David Attenborough's calls for action against plastic pollution**.

Discover more information and view a video about **the life cycle of a plastic bottle** on YouTube (4:06 min).

Discover more about **Tim Silverwood** who studies plastics in the ocean and is the founder of the Take 3 initiative that asks everyone to take away three pieces of rubbish when they leave a beach or waterway.

Watch the video **How we can keep plastics out of the ocean** on YouTube (3:10 min) and conduct some research on the new plastics economy where change makers are designing economies where plastic never becomes waste.

Learn about how Hawaiian students are **taking action against ocean plastic** on YouTube (4:26 min).

Read the following information about marine debris.

What is marine debris?

Marine debris consists of plastic litter washed or blown from land into the sea, fishing gear abandoned or lost by recreational and commercial fishers, and solid non-biodegradable floating materials (such as plastics) disposed of or lost by ships at sea.

Plastic materials are defined as bags, bottles, strapping bands, sheeting, synthetic ropes, synthetic fishing nets, floats, fibreglass, piping, insulation, paints and adhesives.

Seven billion tonnes of various types of litter enter the world's oceans every year. Plastics, which generally make up about 60 percent of rubbish, are the worst offenders and can last for 10–20 years on the ocean floor before decomposing.

Harmful effects of marine debris

Marine debris can have a range of environmental impacts on our marine wildlife and their environment. Marine debris is hazardous for all marine creatures.

Smaller pieces of rubbish, like cigarette butts and fishhooks can be confused with prey and swallowed by marine wildlife causing internal blockages, often resulting in starvation and other complications. Sharp objects are also a major concern, as they may be swallowed, causing damage to an animal's mouth, digestive tract and stomach.

It is estimated that some one million seabirds and 100,000 other marine animals including turtles, whales, dugongs and countless fish are killed as a result of plastic litter every year.

It is estimated that between 50–80 million plastic shopping bags enter the Australian environment as litter every year. If 80 million plastic bags were made into a single plastic sheet, it would cover 16 square kilometres. Each side of the plastic sheet would be 4 km long and it would be big enough to cover the Melbourne central business district.

Although much marine debris ends up on beaches, many items will never float ashore. Many items, particularly nets, become entangled underwater on rocky outcrops and reefs, and some may be washed back out to sea during high winds and tides.

Marine debris can also become a navigational hazard. Debris, especially torn fishing nets, has resulted in the entanglement of rudders and propellers of marine vessels and there have been reports of smaller items clogging cooling water intakes and causing engine failure. Debris is also a hazard to beachgoers, especially children playing on beaches, who may cut themselves on broken glass.

Brainstorm the many ways people can reduce the amount of plastic litter that enters our waterways, oceans and Australian reefs.

As a class, build understanding by sharing ideas and recording issues that the class would like to know more about.

Encourage students to find examples of what people are doing to address sustainable practices and promote ways people can reduce the amount of plastic litter that enters our waterways, oceans and Australian reefs.

Go further and discuss the bigger picture too. Talk about how all people can manage the use of natural resources like the land, freshwater and the ocean more sustainably to ensure other species' needs can be supported as well.

Discover more about a game changer named Boyan Slat who used a high school science project to drive his ideas about how to rid the oceans of plastic pollution.

Dream:

Ask students to imagine the steps involved in designing their blog, poster and brochure.

Check out **50 Outstanding Posters to Inspire Your Next Design** on Pinterest.

Challenge students to think about the materials, tools, and equipment they will need to design their individual work samples. Will they use digital or non-digital equipment and tools?

Ask students how they might communicate the best ways to reduce the amount of marine debris that is washed or blown from the land into the sea, abandoned or lost by recreational and commercial fishers, and disposed of or lost by ships at sea.

Design:

Talk about the importance of a clear layout and design that makes it easy for an audience to understand and interpret the information that is being given.

Discuss the importance of sourcing graphics, photos and information correctly.

Discuss the importance of responsible digital citizenship.

Talk with students about responsible digital citizenship in online environments. Work with students to have them understand appropriate use. Emphasise the principles as described in the 21st Century Fluencies Project:

- Respect themselves
- Protect themselves
- Respect others
- Protect others
- Respect intellectual property
- Protect intellectual property

Source: Crockett, L. & Jukes, I. & Churches, A. (2011) Literacy is not enough. 21st Century Fluency Project Inc, p 81.

Review rules on personal safety, group safety, as well as classroom and furniture safety with the students.

Ask students to establish a workstation and to gather the materials and tools they require.

Talk about safely storing their design and keeping a record of the processes they use to create it.

Ask students to draft the steps involved in making their chosen digital or non-digital designs.

Ask students to gather the materials, tools, and equipment needed and then plan each step involved in creating their digital or non-digital designs.

Invite students to start creating the design of their blog, poster and a brochure that can help people better understand the best ways to reduce the amount of marine debris that is washed or blown from land into the sea, abandoned or lost by recreational and commercial fishers, and disposed of or lost by ships at sea.

Talk with students about how they might share and present their designs to an audience.

Ask students to explain how they plan to finalise and create their designs with another peer in the class and seek feedback on their ideas.

Invite students to create their work samples.

Photograph students at work.

Deliver:

Share work samples that describe the best ways to reduce the amount of marine debris that is washed or blown from land into the sea, abandoned or lost by recreational and commercial fishers, and disposed of or lost by ships at sea.

Ask students to share their designs with others.

Film student presentations of their blog, poster and brochure and enjoy a day of learning about how Australians can reduce marine debris.

Set up tables or booths in the class and invite students, teachers and parents to discover National Science Week in 2018.

Debrief:

Ask students to do the following.

Evaluate their designs and write a paragraph about whether each creation:

- matched the definition of the task,
- used a clear layout and design,
- was feasible, and
- included the sources of the ideas and information each design piece used.

Write about the quality of their planning, their finished designs and whether they enjoyed the task.

Describe their favourite memory of creating their work samples for National Science Week.

Case studies

Enhancing the marine environment

Watch the video **Tangalooma EcoMarines, Bulimba State School** on YouTube (2:00 min) to find out what this Queensland primary school does to enhance the marine environment of Moreton Bay.

No waste here

Watch the video **Student Dedication** on YouTube (1:52 min). Bulimba State School students demonstrate and discuss the ways they reduce, recycle, recover, rethink and remanufacture waste at their school.

Looking after Country

Read **Tagging green turtles with Bardi Jawi rangers keeps Kimberley students busy during school holidays**, (20 April 2016, ABC News) website. The students assist by tagging turtles with satellite transmitters to discover more about their genetics, life cycle, travel and feeding patterns.

Quoin Island Turtle Rehabilitation Centre

Find out about the **Quoin Island Turtle Rehabilitation Centre** and how Quoin Island staff and volunteers rehabilitate sick and injured green turtles off Gladstone in Queensland.

Underwater World rescues, rehabilitates and releases marine turtles

Discover how Underwater World in Mooloolaba helps **Turtles in Trouble**. The centre rescues, then rehabilitates and releases marine turtles in South East Queensland.

Edible spoons

Learn about a startup company in India that is making **edible spoons** to help remove plastic from our lives. YouTube (0:51 min).

Plastic-eating caterpillars

Read about scientists who have discovered that **wax worms can eat through plastic**.

Links to the Australian Curriculum

Science

Year 5 and Year 6

Science Understanding—Biological sciences

The growth and survival of living things are affected by physical conditions of their environment ACSSU094

Science as a Human Endeavour—Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions ACSHE081 ACSHE098

Science as a Human Endeavour—Use and influence of science

Scientific knowledge is used to solve problems and inform personal and community decisions ACSHE083 ACSHE100

Technologies

Year 5 and Year 6

Design and Technologies Processes and Production Skills

Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions ACTDEP024

Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques ACTDEP025

Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions ACTDEP026

Develop project plans that include consideration of resources when making designed solutions individually and collaboratively ACTDEP028

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability OI.2, OI.3, OI.4, OI.5, OI.6, OI.7 and OI.8 Source: (ACARA, 2015)

Activity 2:
What a lot of rubbish

__Boyan Slat__ is a game changer who used a high school science project to drive his ideas about how to rid the oceans of plastic pollution.

Billions of tonnes of litter enter our oceans every year. Is your school managing the waste that it produces in the most sensible way so that it doesn't end up in our stormwater drains, rivers, wetlands and oceans?

Your challenge is to design a system to manage the school's waste more productively and in a way that it doesn't end up in our stormwater drains, rivers, wetlands and oceans.

Investigate:

What waste does the school produce?

What litter do you find continuously in the school grounds?

Does the local council provide any rubbish collection, recycling services or resource recovery options?

What other organisations or businesses collect different types of waste for recycling or resource recovery? Where do they take it? What do they do with it?

Devise solutions:

Design a system for managing all the waste from your school. Take into account: bin positions, whether bins have lids, food waste, green waste, paper, plastics, cans, glass, chemicals, new equipment that might be needed, costs, and any restrictions.

Produce:

Produce a scientific report outlining the system and share it with the School Leadership Team and Parents & Citizens (P&C).

Evaluate:

Sell your system with the School Leadership Team and P&C during National Science Week and consider whether you need to modify or change any parts of the system.

Case studies

Keeping plastics out of the ocean

Learn about the game-changing idea of a new plastics economy where plastic never becomes waste and **how we can keep plastics out of the ocean**. YouTube (3:10 min).

Fungus that can eat plastic

Discover the game-changing scientists who have discovered a **fungus that can break down plastics in weeks**.

Activity 3:
Design a trash rack

The quality of water entering the oceans in and around Australian reefs is declining and this is impacting the health of reef animals and plants. Reefs grow best in waters that have naturally low concentrations of nutrients (nitrogen and phosphorus) and sediments.

It is reported that increasing use of fertilisers, pesticides and other pollutants on the land has resulted in increased levels of these entering our waterways and reefs. This has resulted in the decline in water quality, which has affected corals, kelp forests, seagrasses and other important habitats, as well as the many marine animals they support. Declining water quality can also have a harmful effect on tourism, fishing and other important industries that depend on a healthy reef.

In small groups, your challenge is to design a system for filtering the water entering the oceans in and around Australian reefs that will reduce pollution and silting problems.

Investigate:

Study a natural wetland for ideas. How is the water filtered in a wetland? Does the water enter a wetland from one or multiple points? Does water enter at high velocity? How deep is it?

Investigate how a wastewater treatment plant cleans water. Find out about the filtration processes it uses. Might it have lots of layers of materials that trap particles?

Explore how engineers have designed trash racks that may be used in your catchment area. Check out these designs.

Devise solutions:

In your group discuss ideas. Envision a range of creative solutions. Consider the many possible design solutions and choose the most appropriate, then design your trash rack.

Produce:

On an A3 sheet of card, produce a plan of your design solution.

Evaluate:

Your group is tendering for the next trash rack to be built. Sell your plan to other members of the class. Devise your strategy and share it as part of National Science Week.

Case studies

Reef Aid

Learn about how Greening Australia and Virgin Australia are involved in a **Reef Aid** project to improve water quality on the Great Barrier Reef. They work with landholders and local communities and restore priority habitats, control weeds and improve grazing management practices.

Fatal attraction

Read how husband-and-wife team **Professor Bernard Degnan and Associate Professor Sandie Degnan and a team of researchers** from the University of Queensland (UQ) have made a breakthrough discovery that could protect coral.

Activity 4: Looking into space

Overview: *Explain to the class that their task is to imagine they are change makers or game changers like scientists of today and those who informed us about the solar system in the past. They all have one thing in common—they have brought us discoveries in astronomy and space science. The students task is to use science, technology and art to create a piece for a pop-up Science Week Exhibition titled 'Looking into Space', which visitors of all ages will be invited to enter and explore.*

Background science for students: Astronomy and space science

Astronomy is the study of everything in space. It is the science of things beyond the Earth, including the sun, moon, planets and stars.

Space science encompasses all of the scientific disciplines that involve space exploration and study natural phenomena and physical bodies occurring in outer space, such as space medicine and astrobiology. Source: (**Wikipedia**, 2017)

The essential question:

What happens when we understand that space has been studied by scientists and artists for millennia and is an infinite source for human creativity?

The scenario:

The chairperson of the National Science Week Schools Committee is looking for game changers and change makers in schools to be involved in designing an art installation titled 'Looking into Space'.

'We are looking for young people to discover, examine, and evaluate the extraordinary advances in technology used by space agencies, as well as the scientific endeavours that have involved scientists throughout the ages, which have brought us to a golden age of discovery in astronomy and space exploration.'

Your challenge is to research early and recent astronomers and the people and technologies used in space exploration. Then use science, technology and art to create a piece for a pop-up Science Week Exhibition titled 'Looking into Space', which visitors of all ages will be invited to enter and explore.

Are you up for the challenge?

A suggested learning process:

Define:

Capture students' interest and brainstorm words, phrases and ideas that come to mind when they think about the phrase 'Looking into Space'.

Talk about the role of telescopes, space probes, satellites, spacecraft, rockets, space shuttles, space telescopes and space stations in enabling us to look into space.

Discuss the first humans in space and the first humans on the moon.

Be inspired by an art installation in the Singapore ARTSCIENCE Museum and explore how art can meet science.

View an art installation that showcases an exhibition titled **NASA—A Human Adventure** that featured in Singapore in 2016. YouTube (14:16 min).

Present the scenario, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Capture students' interest and share the following information about early and later astronomers.

Early astronomers were interested in how the universe worked.

In Australia, **Indigenous Australians** are considered the first astronomers.

The **ancient Greeks** also started asking questions about the universe and how it worked.

In the 2nd century BC, **Hipparchus of Nicaea** catalogued more than 800 stars. At a similar time, **Ptolemy of Alexandria** devised a model of the solar system with the Earth at its centre and the sun, moon, planets and stars circling it.

In the 16th century, **Copernicus** tried to persuade people that the sun, not the Earth, was at the centre of the solar system.

In the 17th century, **Tycho Brahe** discovered a supernova and suggested that it was outside the solar system. Also **Johannes Kepler** devised the laws of planetary motion, linking a planet's orbit and speed to the sun.

It was the 17th century, when **Galileo Galilei** began using a telescope and **John Flamsteed** made the first extensive star charts.

In the 18th century, **Caroline Herschel** discovered eight comets and assisted her brother **William Herschel** in the discovery of the planet Uranus.

In the 18th century, **Edmund Halley** predicted the orbit of a comet that was later named after him.

In the 20th century, **Annie Jump Cannon** was instrumental in the development of contemporary stellar classification and is credited with the creation of the Harvard Classification Scheme.

In the 20th century, **Henrietta Swan Leavitt** discovered the relationship between the luminosity and the period of Cepheid variable stars. A Cepheid variable is a type of star that pulsates.

In the 20th century, **Edwin Hubble** determined that there were other galaxies outside the Milky Way.

In the 21st century, **Vera Rubin** aided in the development of a theory for dark matter.

During the 20th and 21st centuries, **Linda Spilker** managed the Cassini mission that probed the study of the planet Saturn and its rings.

In the 21st century, **Jill Tarter** oversaw the construction of an array of 350 radio telescopes that listen for signs of extraterrestrial intelligence.

In the 21st century, **Stephen Hawking** is working on a theory that could unite the four basic forces in the universe, namely gravity, electromagnetism and the strong nuclear and weak nuclear forces.

Invite students to learn more about and be inspired by the following space probes that have been launched from Earth to explore the solar system.

- *Luna 9* that landed on the moon
- *Venera 7* that landed on Venus
- The probe *Ulysses* that studied the sun
- *Voyager 1* and *Voyager 2* that studied the outer planets
- The *Cassini* probe that photographed Saturn
- The *Huygens* probe that was launched from Cassini to land on Titan, a moon of Saturn
- The *New Horizons* probe that researched Pluto
- The *Kepler* mission that is discovering planets orbiting other stars *(NB. This mission is due to end May 2018.)*

Research at least three space probes that may inform your artwork.

Investigate the first humans in space and on the moon.

Find out about the observatories on Earth that use reflecting telescopes and refracting telescopes.

Research the **Australia Telescope National Facility** and investigate their amazing and diverse observatories and technologies that are used to study different aspects of the universe.

Talk about how scientists are still researching so much about the universe that defies explanation.

Dream:

In pairs or small groups, envision or dream about the many possible aspects of astronomy and space science that could feature in an art piece, art installation and art exhibition.

Revisit the Singapore ARTSCIENCE Museum's **NASA—A Human Adventure** exhibit for ideas. YouTube (0:30 sec).

Explore ideas and practices used by artists, including Aboriginal and Torres Strait Islander artists, to represent different scientific ideas.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to also explain and help others understand the extraordinary advances in technology used by space agencies, as well as the scientific endeavours that have involved scientists throughout the ages.

Design:

Invite students in their pairs or small groups to begin drafting their designs for their solutions.

Ask students to draft the steps involved in making their artwork for the pop-up National Science Week exhibition titled 'Looking into Space'.

Ask students to gather the materials, tools and equipment needed and then design and create their solution.

Ask students to plan the display of artworks to enhance the meaning for their audience.

Invite a peer class group to the class to hear from the students and find out more about the extraordinary advances in technology used by space agencies, as well as the scientific endeavours that have involved scientists throughout the ages.

Deliver:

In pairs or small groups showcase their artwork for the pop-up National Science Week exhibition titled 'Looking into Space'.

Classes host a pop-up 'exhibition' titled 'Looking into Space' as part of National Science Week and invite students, teachers and parents to discover what they can learn about space science.

Debrief:

Ask students to reflect on their learning and draw something new they learnt about.

Ask students to describe what worked well and not so well in their efforts to discover, examine, and evaluate the extraordinary advances in technology used by space agencies, as well as the scientific endeavours involving scientists throughout the ages that helped them create their artwork.

Case studies

Learn about how Oakleigh State School in Queensland are involved in the '**Pathways through Mars to success in the digital future**' project.

Find out about schools that are **Designing a Mars Lander** capable of delivering a ten metric ton payload safely to the surface of Mars.

Read about how Hewlett Packard (HP) and the Mars Society are partnering to bring schools the **HP Mars Home Planet** initiative, a program intended to conceive, plan and ultimately, build a virtual colony on the Red Planet that the online public can experience via virtual reality (VR).

Links to the Australian Curriculum

Science

Year 5 and Year 6

Science Understanding—Earth and space sciences

The Earth is part of a system of planets orbiting around a star (the sun) ACSSU078

Science as a Human Endeavour—Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions ACSHE081 ACSHE098

Science as a Human Endeavour—Use and influence of science

Scientific knowledge is used to solve problems and inform personal and community decisions ACSHE083 ACSHE100

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS231 ACSIS232

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks ACSIS086 ACSIS103

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts ACSIS093 ACSIS110

The Arts

Year 5 and Year 6

Visual Arts

Explore ideas and practices used by artists, including practices of Aboriginal and Torres Strait Islander artists, to represent different views, beliefs and opinions ACAVAM114

Develop and apply techniques and processes when making their artworks ACAVAM115

Plan the display of artworks to enhance their meaning for an audience ACAVAM116

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability. Source: (ACARA, 2015)

Cross Curriculum Perspective:

Aboriginal and Torres Strait Islander Histories and Cultures OI.3 Source: (ACARA, 2015)

Activity 6:

Create a talking avatar

Avatars have been used over the years in video games, cartoons, movies and now they also appear as virtual assistants in online chat boxes.

Imagine how a talking avatar could promote the 200th anniversary of the publication of *Frankenstein* by **Mary Shelley.** The book became an immediate bestseller and Shelley was only eighteen years of age when she delved into the world of science and medicine, and created her character who comes back to life.

Delve deeper into the concept of Mary Shelley's creature, which is designed and created from human body parts and infused with the essence of life by an electric shock.

Probe into **Mary Shelley's** book, and step into the character of her scientist-hero, Victor Frankenstein.

What might your Frankenstein-inspired avatar say?

What might it look like?

What might it actually be used for?

Exercise your imagination and design your own Frankenstein-inspired avatar and share it as part of National Science Week.

Find out more about creating avatars at **http://www.voki.com/**

Activity 7: Cybernetics technology

Overview: *Explain to the class that their task will be to explore a range of ways that human bodies are being modified, and clinically enhanced. Their task is to think about how humans are being transformed by science and technology as part of National Science Week.*

Background science for students: What is a scientist?

A scientist is someone who uses a systematic approach to acquire new knowledge. A scientist can also be defined as someone who uses the scientific method and performs research work.

A scientist may be an expert in one or more areas of science, such as biology, medicine, agriculture, space, food, nutrition or plants.

Being a scientist begins by *thinking* like a scientist. Scientists are curious about how the world works; they have many questions and go about answering those questions using the scientific method.

If you are fascinated by how things work and why they work a certain way, you too could become a scientist.

To work as a scientist, a person usually needs a degree in science. A degree is obtained by attending university and getting a Bachelor of Science or an Engineering degree.

The essential question:

What is the best way to get people thinking about ways the human body is being modified, clinically enhanced and transformed as part of National Science Week?

The scenario:

The National Science Week team is searching for schools to investigate ways the human body is being modified, clinically enhanced and transformed as part of National Science Week this year.

There are ways to bring awareness to the theme 'Game Changers and Change Makers' and to the issues of responsible body modification, enhancement and transformation.

Leading scientists, technologists and engineers are showing us how technology can help many people. There are a number of implanted electronic devices like the 'Cochlear ear' that have been developed to fix a problem, rather than to transform current human capabilities.

There are also many scientists, technologists and engineers developing prosthetics that replace missing body parts.

As part of National Science Week, bring your ideas alive about the best way to get people thinking about ways the human body is being modified, enhanced and transformed with rich images and a unique story and share them with the National Science Week team and others in your community. What about a video, animated cartoon, or documentary?

A suggested learning process:

Define:

Capture students' interest by sharing a video about **The LUKE Arm** (named after Luke Skywalker) that is helping injured war veterans. YouTube (2:23 min).

Talk about devices like robotic limbs that assist people in their everyday lives.

Ask students what they might need to know more about, in order to undertake the challenge set by the National Science Week team. Might they need to know something about the key challenges to responsible body modification, enhancement and transformation?

Brainstorm what students know about responsible body modification, enhancement and transformation. List key words and create a mind map to show links between the students' ideas.

Discover:

Read about or view the TED Talks with **Aimee Mullins** about the prosthetic leg she wore in the 1996 Paralympics Games in Atlanta.

Discover her ideas about changing the perceptions of people with varying abilities, and her hope for greater acceptance of people's individuality and difference.

Talk about Aimee's ideas.

Ask the students the questions: 'What can we do?', 'What can we talk about?', 'What can we advocate for?', in relation to body modification, enhancement and transformation.

Brainstorm ideas and collate them around the question: 'What is the best way to get people thinking about ways the human body is being modified, enhanced and transformed as part of National Science Week?'

Go further and discover information about **The Eyeborg Project** where a missing eye has been replaced by a prosthetic.

Discover more about the types of technologies that support life that are implanted. For example, the Left Ventricular Assistance Device (LVAD) that provides a bridge to heart transplantation for patients with heart disease. Explore the functions and benefits of insulin pumps that maintain people's kidney functions.

Talk about the value of such technological devices for people.

Investigate the **Alternative Limb Project** on YouTube (4:34 min) and consider issues of body modification, enhancement and transformation.

Ask students to brainstorm ideas for videos, animated cartoons, and/or documentaries.

Invite students to select the idea that really 'grabs' them, and then draft their storyboard.

Dream:

Ask students to visualise a work sample that speaks about the issues of body modification, enhancement and transformation.

Ask students to imagine what their work samples might look like and how they will bring awareness to the theme 'Game Changers and Change Makers' and to the issues of body modification, enhancement and transformation.

Design:

Ask students to design their work sample.

Ask students to gather the materials, tools, and equipment needed and then design their work sample.

Deliver:

Create the work samples about the theme 'Game Changers and Change Makers' and body modification, enhancement and transformation.

Deliver work samples to real audiences during National Science Week and discuss the issues of body modification, enhancement and transformation.

Share photos and students' work samples and presentations via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of young people in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek. Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to recall what they learned.

Talk about what they might still like to find out.

Discuss the phrase spoken by John F Kennedy (President of the United States 1961–1963), "One person can make a difference and everyone should try it". Discuss with students whether they feel empowered and whether they can make a difference after their learning in this unit of work?

Ask students to describe their favourite part of creating a work sample about game changers and change makers and showcasing the issues of body modification, enhancement and transformation.

Case study

Read about **Today's Most Advanced Real Life Cyborgs**.

Links to the Australian Curriculum

Science

Year 5 and Year 6

Science as a Human Endeavour—Nature and development of science

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena and reflects historical and cultural contributions ACSHE081 ACSHE098

Science as a Human Endeavour—Use and influence of science

Scientific knowledge is used to solve problems and inform personal and community decisions ACSHE083 ACSHE100

Science Inquiry Skills

With guidance, pose clarifying questions and make predictions about scientific investigations ACSIS231 ACSIS232

Identify, plan and apply the elements of scientific investigations to answer questions and solve problems using equipment and materials safely and identifying potential risks ACSIS086 ACSIS103

Compare data with predictions and use as evidence in developing explanations ACSIS218 ACSIS221

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts ACSIS093 ACSIS110

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability. Source: (ACARA, 2015)

Activity 8:

Watch genetic traits at work!

You probably think it's quite obvious that your brother or sister look like your parents. But why is this? Why do some of us look more like one parent than another?

The answers to these questions lie deep in our cells... and cells are the building blocks from which all living things are made. The 'plans' of our individual bodies, how they look and how they work, are held in chemical patterns called 'genes'.

All babies's genes contain a mixture of genes from their parents.

In the 19th century, it was **Gregor Mendel** who thought through the main laws of inheritance and this was a long time before genes were discovered. In the 20th century, **Maxine Singer**, a molecular biologist, helped draft the safety guidelines for genetic engineering.

Investigate:

Genetics is the study of how the characteristics of living creatures are are passed on. Find out about any of the characteristics that have been passed on in your family.

What to do:

Make up ten 'Genetic Traits' scorecards, each with six tick boxes.

Write the following types of traits that can be inherited on to separate cards.

- Attached earlobes
- Freckles
- Can roll your tongue
- Naturally red hair
- Naturally curly hair
- Dimples
- Food allergies
- Left-handed
- Cleft chin
- Suffers from hay fever

Place the cards in a bag, and invite family members to draw a card from the bag and read it out loud. Any player who has the trait on the card ticks the box. The player with the most traits wins.

Students should report their findings to their classmates at school.

Activity 9:

Extract your own DNA!

DNA is short for deoxyribonucleic acid, and it is just like an instruction manual telling your body how to grow.

Did you know that DNA typically exists as large molecules found inside cells? It contains all the information needed for a body to grow.

It was **Francis Crick, James Watson and Rosalind Franklin** who in the 1950s studied X-rays of DNA to work out a range of possible DNA shapes and discovered the structure of DNA.

A DNA molecule looks like a twisted ladder. However the rungs of DNA are not all the same. They are a bit like the different letters in the alphabet. They can be arranged to form instructions, just like letters can be arranged to make words. Each instruction is called a 'gene'. One gene might be 'the eye colour is blue'. Another might be 'the hair colour is brown'. The genes on every person's DNA are slightly different, except for those of identical twins.

Thanks to the discoveries of Crick, Franklin and Watson, and many other scientists, we can now treat some illnesses caused by faulty genes. Criminals can also be tracked from tiny traces of DNA that they may leave at crime scenes.

You will need:

- Small recyclable paper cups
- A bottle of colourless sports drink
- Liquid soap
- Pineapple juice
- A wooden skewer
- A small amount of alcohol (ethanol), used with the help of an adult
- A jar with a lid

What to do:

Place the alcohol in the freezer for 24 hours before starting the activity.

Swish a mouthful of sports drink in your mouth for 2 minutes.

Spit the sports drink into a cup.

Pour it into the jar until at least one-third full.

Add liquid soap until the jar is half full.

Place the lid on the jar and gently mix its contents.

Add a few drops of pineapple juice.

Mix again.

Carefully add a little alcohol so that it floats on top.

Swirl the skewer around the white gooey material near the top—your DNA!

GAME CHANGERS & CHANGEMAKERS

For the

Secondary Years of Schooling

Years 7–10

FEAST
By OzHarvest

Food Education Sustainability Training

OZHARVEST'S NEW FEAST PROGRAM WILL INSPIRE KIDS TO EAT HEALTHY, WASTE LESS AND BE CHANGE-MAKERS IN THE LOCAL COMMUNITY.

FEAST is full of fun, interactive activities for students as they explore the role food plays in everyday lives and the importance of protecting the planet.

The program is a classroom presented, inquiry based unit, focused on detailed lesson planning tools and recipes that align with Australian Curriculum Links and embraces the STEM context, and the sustainability cross-curriculum priority.

THE EXCLUSIVE PRIMARY SCHOOL LAUNCH FOR OZHARVEST'S FEAST PROGRAM STARTS SOON.

FOR MORE INFORMATION AND TO REGISTER YOUR INTEREST EMAIL FEAST@OZHARVEST.ORG

OZHARVEST
Nourishing Our Country

Activity 1: The bionics boom

Overview: *Explain to the class that they will be exploring the evolution of computer power and computer applications that can control muscle movements, restore vision for the blind, and hearing for the deaf.*

Background science for students: Computer power and Moore's law

From now to the year 2050, scientists foresee an explosion in scientific activity such as the world has never seen. It is predicted that in the key technology area of quantum computing we will see entire industries rise and fall based on breathtaking scientific advances.

Since the 1950s, the power of computers has advanced by a factor of roughly ten billion, and one can compute the period over which many scientific breakthroughs may take place. This means that predictions about the future of computers can be quantified with reasonable accuracy.

For computers, this growth rate is quantified by Moore's Law, which states that computer power will increase exponentially. This was first stated in 1965 by **Gordon Moore**, co-founder of the Intel Group.

More recently, Moore's Law has been challenged as advances have exceeded previously held beliefs on which Moore's Law was based. Scientists expect this relentless drive to continue to generate faster and more powerful computers.

Scientists have explored how these microprocessors can interface directly with the brain and have shown that individual neurons can grow and thrive when associated with silicon chips. In 1995, a team of change makers led by **Peter Fromherz**, from the Max Planck Institute of Biochemistry just outside Munich in Germany, successfully demonstrated how a neuron could fire and send a signal to a silicon chip, and that a silicon chip can make the neuron fire. This paved the way to developing silicon chips that could control the firing of neurons at will, which in turn could control muscle movements. This was the beginning of bionics.

The essential question:

What is the best way to get people thinking about and finding solutions to the evolution of computer power and computer applications that can control muscle movements, restore vision for the blind and hearing for the deaf in the 21st century?

The scenario:

A multi-billion-dollar computer corporation is searching for schools to investigate microprocessor technologies to aid in the design of possible new applications where such technologies could benefit medical science. They also wish to promote awareness of these opportunities as part of National Science Week this year.

Microprocessors are cheap and plentiful, due to the expansion and development of silicon chips and portable devices such as mobile phones. Applications (apps) are found in smart homes, cars, TVs, clothes, and jewellery. Because of apps, we can even speak to our digital devices, and they speak back to us.

The computer corporation invites you to design an application where we may be able to implant microprocessor technology into artificial arms, legs, ears, or eyes to aid people with special needs and disabilities.

Are you up for the challenge?

What kind of game changer or change maker might inspire your thinking and designs?

A suggested learning process:

Define:

Share the essential question with the class and talk about the scientific applications that might be addressed.

Present the scenario, assign groups if appropriate, and ask students to define the task they have been set.

Discover:

Capture students' interests by reading a **STEM article** about the range of bionic body parts available to us today.

View the Nine News episode, **Australian-first bionic breakthrough allows amputees to use 'thought' to control artificial limbs** (2:59 min) about a recent Australian game changer who developed an intelligent prosthetic that uses thought to control artificial limbs.

Read the **Intelligent Prosthetics** article about British game changers, all of them engineers working for the Blatchford Group, who developed intelligent prosthetics and find out about the engineering behind Linx.

Hear from Chieko Asakawa in her TED Talk, **How new technology helps blind people explore the world** (9:29 min), and discover how her smartphone and its technology are enabling her and others who are blind to explore the world.

Read about **Cyborg tech** and see their suggestions that cutting-edge science is opening up a new era in medicine, where preventing, diagnosing and treating health problems is based on a person's unique DNA.

Read the article, **The world's first bionic kidney is all set to replace dialysis in just two years**. This kidney consists of several microchips made with silicon nanotechnology.

Brainstorm and talk about the sort of changes the class would like to see in the fields of biomedical engineering, biotechnologies, prosthetics, and bionics.

Find examples of game changers and change makers in Australia or overseas who have connected microprocessor technologies to parts of the human body and aided many people worldwide. For example:

- Investigate Professor Graham Clark, an Australian doctor, and Nucleus Limited, a company that manufactured the ‘bionic ear’ commonly known as the ‘Cochlear Multi-Channel Prosthesis’.
- Research how doctors at the Harvard Medical School’s Massachusetts Eye and Ear Infirmary built the ‘bionic eye’ and implanted computer chips into human eyes, restoring vision for many people who are blind or suffer from macular degeneration.
- Read **Bionic eyes, arms and spines are no longer science fiction** to find out how Bionic Vision Australia is designing new and innovative applications that are restoring the sight of many Australians and find out about bionic arms and eyes.
- Research how Dr Oritz-Catalan from Sweden’s Chalmers University has designed bionic arms that are ossio-integrated into the bones, nerves and muscle tissue of patients thereby providing superfine muscle control.
- Explore how Dr Thorvaldur Ingvarsson has designed **Ossur**, a mind-controlled bionic prosthesis for amputees.
- View an episode of **Future Now** that explores how we can repair the human body in incredible ways including 3D printing (Note: Users need to register to use this site).

Encourage students to think about the world beyond 2020, where we may be able to connect silicon microprocessors with other parts of the human body and its nervous system. Discuss how such change might aid people with disabilities and severe illnesses.

Similarly, talk about merging our mind, spinal cord, internal organs and machines. Discuss scientists who are trying to connect a variety of organs and our spinal cord to silicon microprocessors. As an example, ask students to imagine a person with damage to their spinal cord at C5 (in the neck). By placing an external sensor (A) at a position above the damaged cord that is able to read the signals coming down the spinal cord and another sensor (B) on a position below the damaged area, could the signals from (A) be transmitted to (B) via wi-fi and stimulate the required nerve endings and in return provide the appropriate signal when that person stubs their toe and the required signal returns to the brain to indicate pain?

Discuss applications of this type that can read signals from the brain through the spinal cord and ask students to envision how such innovations might be embedded into their designed solution that can benefit the lives of people with special needs or disabilities.

Where possible locate the book *Mind Children* by Hans Moravec, who in 1988 imagined and wrote about a bionic merger between humans and machines. He envisioned humans in the distant future being able to gradually transfer their consciousness from their bodies to a robot. Talk about how such a scenario might be out of reach for some time, if attainable at all and discuss whether it is ethical to have all the memories and thought patterns of the original person housed in a mechanical body of silicon and steel… one that can potentially live on forever.

Dream:

Ask students to imagine the steps involved in designing their solution.

Challenge students to think about the materials, tools, and equipment they’ll need to design their individual work samples. Will they use digital or non-digital tools?

Ask students how they might communicate the features and benefits of their application where they hope to be able to implant microprocessor technology into parts of the human body to aid people with special needs and disabilities.

Talk about the importance of a clear layout and design that makes it easy for an audience to understand and interpret the information that is being given.

Discuss the importance of sourcing and acknowledging graphics, photos and information correctly.

Talk with students about responsible digital citizenship in online environments. Work with students to have them understand appropriate use. Emphasise the principles:

- Respect themselves
- Protect themselves
- Respect others
- Protect others
- Respect intellectual property
- Protect intellectual property.

Source: Crockett, L & Jukes, I. & Churches, A. (2011) Literacy is not enough. 21st Century Fluency Project Inc, p 81.

Ask students to create the designs and gather the materials and tools they require.

Talk about safely storing their designs and keeping a record of the processes they use to create them.

Ask students to draft the steps involved in making their chosen digital or non-digital designs.

Invite students to begin creating their designed solutions.

Talk with students about how they might share and present their designs to an audience as part of National Science Week.

Ask students to explain how they plan to finalise and create their designs with a peer in their class and seek feedback on their ideas.

Invite students to design work samples that feature an application such as a microprocessor technology that can be implanted into the human body to aid people with special needs and disabilities.

Photograph students at work.

Deliver:

Ask students to present their designs to the class, other classes and/or parents.

Video the students' presentations as part of National Science Week.

Set up a 'Bionics' multimedia presentation for other audiences to view and learn from as part of National Science Week.

Debrief:

Ask students to evaluate their designed solution and write about whether their design:

- matched the definition of the task,
- used a clear layout and design,
- was feasible, and
- included the sources of the ideas and information about each design piece that was used.

Ask students to reflect on the quality of their planning, their finished design and what they learned about scientists who are using science understanding and skills in their occupations, as well as developing solutions to contemporary issues by working in the field of bionics.

Case study

Read about **Today's Most Advanced Real Life Cyborgs**.

Links to the Australian Curriculum

Technologies

Year 7, Year 8

Design and Technologies Knowledge and Understanding

Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures ACTDEK029

Year 9 and 10

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved ACTDEK040

Science

Year 7 and 8

Science as a Human Endeavour—Use and influence of science

Solutions to contemporary issues that are found using science and technology, may impact other areas of society and may involve ethical considerations ACSHE120 ACSHE135

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE121 ACSHE136

Science as a Human Endeavour—Nature and use of science

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures ACSHE223

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability. Source: (ACARA, 2015)

Activity 2: Reefs at risk

***Overview:** Explain to the class that their task is to imagine they are change makers or game changers like marine scientists and artists of today. Their task is to use science, technology and art to create a piece for a pop-up National Science Week exhibition titled 'Reefs at Risk', which visitors of all ages will be invited to enter and explore.*

Background science for students: Marine biology

Marine biology is the scientific study of organisms in the sea. Given that in biology, many phyla, families and genera have some species that live in the sea and others that live on land, marine biology classifies species based on the environment rather than on taxonomy.

The study of marine biology dates back to **Aristotle** (384–322 BCE), who made many observations regarding life in the sea around Lesbos, Greece, laying the foundation for many future discoveries.

Today, marine scientists study and undertake research about marine life, their habitats and risks they face. Source: (**Wikipedia**, 2017)

The essential question:

What happens when we understand that reefs and marine life have been studied by scientists and artists for millennia and provides an infinite source for human creativity?

The scenario:

The chairperson of the National Science Week Schools Committee is looking for game changers and change makers in schools to be involved in designing an art installation titled 'Reefs at Risk'.

We are looking for young people to discover and examine endeavours that have involved scientists and/or artists communicating their concerns about our reefs that are at risk.

Your challenge is to research threats to reefs and study ways in which scientists and artists have communicated that we can protect, manage and conserve reefs.

Then use science, technology and art to create a piece for a pop-up National Science Week exhibition titled 'Reefs at Risk', which visitors of all ages will be invited to enter and explore.

Are you up for the challenge?

A suggested learning process:

Define:

Capture students' interest and brainstorm words, phrases and ideas that come to mind when they think about the phrase 'Reefs at Risk'.

Talk about the reefs that are known to the class. List these and ask students to refer to atlases, reference books and websites for support material about one of their choice.

Ask students to undertake a scientific inquiry into their chosen reef and discover detailed information about the reef's:

- characteristics;
- distribution;
- biodiversity;
- current use;
- threats, risks and issues affecting it;
- impact that human activity is having on the reef; and
- ecologically sustainable management.

Be inspired by an art installation in the **Singapore ARTSCIENCE Museum** and explore how art can communicate scientific ideas.

View an art installation that showcases an exhibition titled **The Deep** that featured in Singapore in 2016. YouTube (1:59 min).

Present the scenario, assign student pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Invite students to learn more about reefs and the threats they face. Consider issues like climate change, coral bleaching, water quality and the crown-of-thorns starfish.

Using the video **Australia's Great Southern Reef Ocean Imaging** (1:05 min), discover the amazing biodiversity within its waters and some of the risks it faces.

Ask students to research at least three threats, risks or issues that may inform their artwork.

View an episode of the ABC's *Catalyst* program hosted by Professor Emma Johnston, **Can We Save the Reef?** (57 min), and learn about game-changing scientists who are taking action for the reef.

Explore a **number of reef videos** produced by Catlin Seaview who, since 2012, has created a digital record of 600,000 images across reef systems from 60 countries.

Check out some amazing underwater photography by **Carl Charter** who photographs marine life in the Great Southern Reef.

Learn about **Coral Watch**, an initiative in Queensland, and how it undertakes reef conservation activities.

Learn about **Reef Check Australia** and what it does to protect reefs.

Discover Greening Australia and Virgin Australia's program titled **Reef Aid**.

Introduce students to The Great Barrier Reef Marine Park

Authority's **Eye on the Reef** program that uses citizen science to help understand what's going on. Watch the **Eyes on the reef** video about the threats and dangers it is facing.

Talk about how scientists are still researching so much about reefs that defies explanation.

Read the following web page for information about the **art, music and dance** connections of Aboriginal and Torres Strait Islander people to the Great Barrier Reef.

View images of **reef art** by Aboriginal and Torres Strait Islander people.

Check out images by a range of artists who have been inspired by reefs.

Dream:

In pairs or small groups, envision or dream about the many possible aspects of reef science that could feature in an art piece, art installation or art exhibition.

Explore ideas and practices used by artists, including Aboriginal and Torres Strait Islander artists, to represent different scientific ideas.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, equipment and ingredients they will need to make their solution a reality.

Remind students that their solution needs to also explain and help others understand the threats to reefs as well as study ways we can protect, manage and conserve reefs.

Design:

Invite students in their pairs or small groups to begin drafting their designs for their solutions.

Ask students to draft the steps involved in making their artwork for the pop-up National Science Week exhibition titled 'Reefs at Risk'.

Ask students to gather the materials, tools and equipment needed and then design and create their solution.

Ask students to plan the display of artworks to enhance meaning for their audience.

Invite a peer class group to the class to hear from the students about the threats to reefs and ways in which we can protect, manage and conserve reefs.

Deliver:

Pairs or small groups showcase their artwork for the pop-up National Science Week exhibition titled 'Reefs at Risk'.

Classes host a pop-up exhibition titled 'Reefs at Risk' as part of National Science Week and invite students, teachers and parents to discover what they can learn about reefs.

Debrief:

Ask students to reflect on their learning and draw something new they learnt about.

Ask students to describe what worked well and not so well in their efforts to discover, and examine the threats to reefs and ways in which scientists and artists have communicated how we can protect, manage and conserve reefs.

Case studies

Fatal attraction

Read how husband-and-wife team **Professor Bernard Degnan and Associate Professor Sandie Degnan and a team of researchers** from the University of Queensland (UQ) have made a breakthrough discovery that could protect coral.

Transplanted kelp forest

Investigate a **scientific research project** off the Tasmanian coast that has opened up new fields of knowledge in the restoration of marine ecologies.

Links to the Australian Curriculum

Science

Year 7 and 8

Science as a Human Endeavour—Use and influence of science

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations ACSHE120 ACSHE135

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE121 ACSHE136

Science as a Human Endeavour—Nature and use of science

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures ACSHE223

The Arts

Year 7 and 8

Visual Arts

Present artwork demonstrating consideration of how the artwork is displayed to enhance the artist's intention to an audience ACAVAM122

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Perspectives:

Aboriginal and Torres Strait Islander Histories and Cultures OI.3 and Sustainability OI.3, OI.7 and OI.8. Source: (ACARA, 2015)

Activity 3: What choices do we have?

Overview: *Explain to the class that their task is to consider what is ethically and socially responsible in the world of DNA testing and cloning.*

Background science for students: Authoring scientific creations

In Mary Shelley's book titled ***Frankenstein,*** the scientist Dr Victor Frankenstein, wrestles with the moral dilemma of creating a companion for his creature. If the union had produced children, then Dr Frankenstein may have created a 'designer child' or first-ever 'clone'.

Two hundred years after Shelley's writing, genetic engineering and cloning are scientific methods used in our gardens, where we use cuttings to create genetically identical copies of plants. Sometimes in our supermarkets, we may find some foods (wheat and potatoes) which are 'clones', having been derived from specially bred plants.

Successful cloning of animals had eluded scientists until recently when British scientists cloned a sheep called 'Dolly'. In 1997, it was **Ian Wilmut** from the Roslin Institute in Scotland who cloned the sheep by extracting a cell from the mammary gland of an adult sheep.

In principle, cloning can be performed in two ways. The first is to remove cells from an embryo before they have differentiated into cells for skin, muscle, and neurons, and then alter and culture them in a laboratory, before medically inducing them into a surrogate mother. The second method involves taking an embryonic cell and regenerating it, as Ian Wilmut did when he cloned a sheep from an adult cell.

Since 1997, many other animals are being authored and reshaped.

Essential question:

What happens when we understand that solutions to contemporary issues, that are found using science and technology, may impact on other areas of society and may involve ethical and welfare considerations?

Scenario:

The DNA revolution gives us many divergent visions of the future. One vision, suggested by the biotech industry, is that of health and prosperity with gene therapy eliminating hereditary diseases and possibly curing cancer in humans.

Ian Wilmut's scientific investigations produced the first cloned sheep by extracting a cell from the mammary gland of an adult sheep.

Since then glow-in-the-dark animals have also been produced.

Is it ethical to manipulate genes, and if so, under what guidelines?

Your ethics team has been approached by a local National Science Week Coordinating Committee. They want you to promote the concept of a 'good citizen' along with being an 'ethical scientist', so that ethical decision-making and the consideration of animal welfare takes account wider impacts, especially as they pertain to changing the structure of DNA and producing new organisms.

Your challenge is to consider the effect of DNA changes on individual living things and help others understand what you think is socially and ethically responsible behaviour.

Are you up for the challenge?

If so, then celebrate your science investigations, create a scientific report or presentation and host an Investigating DNA Day as part of National Science Week.

A suggested learning process:

Define:

Capture students' interest and share a video about **Dolly the sheep** who was cloned in 1997.

Talk about contemporary issues that involve cloning and genetic engineering that students think schools should help young people studying science explore.

Present the scenario, assign pairs or small groups if appropriate, and ask students to define the task they have been set.

Discover:

Discover information about how and why we reshape organisms like mice, dogs, cats, cattle, carrots, viruses and cotton as well as grains such as corn and wheat to suit our needs and desires.

Ask students questions like:

- Do you think people might think it ethical to manipulate DNA and reshape organisms?
- What are some of the positive aspects of this issue?
- What are some of the more negative aspects about such activities?
- What might be the advantages and disadvantages of genetically engineering organisms?
- Who might benefit and who might lose in these possible scenarios where we are authoring our environment?
- Can you describe what is socially and ethically responsible in this area of science?

Talk about the word 'ethical'. How might the students describe an ethical way to handle animals in laboratories? Why might they need to be handled and treated ethically?

Collate ideas about the methods and standards of handling animals in laboratories and how these have changed over time using a mind mapping app, or map ideas using a concept-mapping technique.

Investigate companies like Monsanto and Bayer that genetically engineer a range of organisms.

Discover a game changer like **Maxine Singer**, a molecular biologist who helped draft the first safety guidelines for genetic engineering.

Introduce SWOT analysis. Talk about 'SWOT' being an acronym for **S**trengths, **W**eaknesses, **O**pportunities and **T**hreats and how a **SWOT** analysis can help identify vital areas to either emphasise or improve the process of genetically engineering organisms.

Model the use of a SWOT analysis using a locally relevant example.

Ask students to undertake a SWOT analysis using an example where an organism is being genetically engineered and identify the following.

- Strengths of the genetically engineered system featured.
- Weaknesses of the genetically engineered system shown.
- Real opportunities that the genetically engineered system featured offers in terms of sustainable and ethically produced organisms and/or products.
- Real threats that might impact on industry's suggestions that they are committed to producing sustainable and ethically processed and produced organisms and/or products.

Ask students to clarify ideas and explanations and summarise these in written form.

Investigate **cloning**.

Explore the issues uncovered and use **Edward de Bono's Six Thinking Hats** to think through the issues according to each coloured hat.

Use a Positive, Minus, Interesting (PMI) chart to revisit and analyse the associated advantages and disadvantages and interesting welfare and/or ethical features or considerations being used in cloning and genetically engineered contexts. When using a PMI consider the following:

- Pluses—focussing on the perceived positive outcomes
- Minuses—focussing on the perceived negative outcomes
- Interesting to see—being the issues and questions that arise from that idea.

Ask students how they might communicate the ways their ideas, scientific report or presentation might communicate their findings about the effect of DNA changes on individual living things and help others understand what is thought to be socially and ethically responsible.

Dream:

In pairs or small groups, envision or dream about the many possible solutions to a preferred future in which ethical and welfare considerations are used to inform any cloning or genetic engineering.

Further develop ideas for possible solutions using sketches and labels.

Ask students to visualise their most creative solution.

Invite students to think about what materials, tools, and equipment they will need to make their solution a reality.

Remind students that their solution needs to also explain and help others understand what is thought to be socially and ethically responsible when manipulating cells, changing the structure of DNA and producing new organisms.

Design:

Invite students in their pairs or small groups to begin drafting their designs for their solutions as part of a scientific report or presentation to share with others as part of National Science Week.

Ask students to draft the steps involved in making their Investigating DNA Day event.

Ask students to gather the materials, tools and equipment needed and then design and create the report or presentation.

Invite a peer class group to the class to hear about what the students think is socially and ethically responsible when manipulating cells, changing the structure of DNA and producing new organisms.

Deliver:

Pairs or small groups showcase their ideas about what is socially and ethically responsible when manipulating cells, changing the structure of DNA and producing new organisms.

Classes host an Investigating DNA Day as part of National Science Week and invite students, teachers and parents to discover more about the issue.

Debrief:

Ask students to reflect on their learning and something new they learnt about.

Ask students to describe what worked well and not so well in their efforts to engage others in thinking about what is socially and ethically responsible when manipulating cells, changing the structure of DNA and producing new organisms.

Links to the Australian Curriculum

Science

Years 7, 8, 9 and 10

Science as a Human Endeavour—Use and influence of science

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations ACSHE120 ACSHE135

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE121 ACSHE136

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities ACSHE160 ACSHE194

Values and needs of contemporary society can influence the focus of scientific research ACSHE228 ACSHE230

Science as a Human Endeavour—Nature and use of science

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures ACSHE223

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved ACTDEK040

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions ACTDEK041

Technologies

Years 9 and 10

Design and technologies Knowledge and Understanding

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved ACTDEK040

Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions ACTDEK041

Investigate and make judgments on the ethical and sustainable production and marketing of food and fibre ACTDEK044

Design and Technologies Processes and Production Skills

Apply design thinking, creativity, innovation and enterprise skills to develop, modify and communicate design ideas of increasing sophistication ACTDEP049

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability OI.2, OI.3, OI.4, O1.5, OI.6, OI.7, OI.8 and OI.9.
Source: (ACARA, 2015)

Activity 4: Make a positive difference

Overview: *Explain to the class that their task will be to educate the broader community to understand how game changers and change makers advocate for a stable climate, clean water supplies, sanitary waste disposal, clean oceans, and active and informed citizens.*

Background science for students: Climate science

Climate science looks at past, present and future climate systems and seeks to understand the impact of these on physical, biological and human environments.

Climate science focuses on the longer term (for example, seasonal variability and climate change) whereas meteorology (the study of weather) focuses on the short-term, day-to-day changes.

Climate scientists aim to develop a coherent and systematic understanding of linked processes using a vast range of measurements (e.g. from the deep oceans to satellites) and sophisticated computer modelling approaches to test our understanding of the factors that affect climate (such as greenhouse gas emissions) and the things climate affects (such as food security). Usually climate scientists would have a strong background in mathematics, physics, biology and environmental sciences.

Source: Professor Mark Howden, Director Climate Institute, Australian National University, Canberra.

The essential question:

What happens when we understand how societies depend on a healthy environment, a stable climate, clean water supplies, sanitary waste disposal, clean oceans, and active and informed citizens?

The scenario:

Arguably, there has never been a time in history where knowledge of global environmental change has been greater than it is today. Game changers and change makers like climate scientists, atmospheric scientists, geochemists, oceanographers, agronomists, and biologists have researched and published their specialist knowledge and findings about the Earth as it is today and was in the recent past. However, millions of people do not understand what is needed for a sustainable future.

Your task is to educate the broader community to understand how game changers and change makers advocate for a stable climate, clean water supplies, sanitary waste disposal, clean oceans, and active and informed citizens. Do you create a presentation, a series of podcasts, a video, a documentary or write a scientific report?

A suggested learning process:

Define:

Capture students' interest by watching **Leonardo DiCaprio's moving speech on climate** on YouTube (1:05 min) about the massive behavioural changes he believes are needed for the Earth.

Talk about the importance of working together to create solutions.

Talk about the messages conveyed in the video.

Ask students what they might need to know more about in order to undertake the task set for National Science Week. Do they need to know something about the key challenges to global sustainability? Do they need to know something about the changing climate, the water cycle, or the carbon cycle?

Brainstorm what students know about climate change, clean water supplies, sanitary waste disposal and key challenges to clean oceans. List key words and create a mind map to show links between the students' ideas.

Discover:

Climate change

Discover more about climate change. Much of the latest climate science is freely available online.

A special report on climate change in *New Scientist* set out what is now known to be certain and what still needs clarifying regarding the phenomenon.

It is generally agreed that the emission of greenhouse gases during the 20th century has raised the average global temperature by 0.8 degrees Celsius, and as a result: our planet is considerably warmer; sea levels are rising when the oceans warm and expand; ice sheets have progressively reduced causing worrisome feedback effects; warm air is holding more moisture causing greater frequency in rain events and more intense storm and cyclonic conditions; changes in precipitation patterns; increasing numbers of heat related deaths (particularly among children and old people); and great biodiversity loss.

… Research is in progress to clarify more regarding our changing climate and the likely impacts. Climate sceptics, friends of the fossil fuel industry and media personalities have alternative viewpoints and understandings, but largely, the empirical evidence shows the effects of a changing climate on economies, environments and societies are an important topic of study.

Source: Le Page, M. (2011) 'Special report: climate change'. New Scientist, 22 October, 36–43.

In groups, explore the issues presented and list ideas concerning understandings about climate change.

Ask students to develop a concept map describing what they know about: climate change, what it is, what it comprises, what it affects, its potential impacts on living things in a variety of ecosystems, and who and what produces emissions that that can affect the Earth's climate.

Use **Simple Mapper** or the **web map** from the Global Education website to develop a concept map.

Create a mind map and collate ideas or create a **Wordle** or word cloud.

Discover more about global temperatures and how they have changed. Explore the website **Climate Lab Book** and view **a spiral graph** that highlights global temperature changes from 1850–2016.

Undertake further research and read the article **Ice Core Data Help Solve a Global Warming Mystery**, on the *Scientific American* website which explains how current polar records show connections between atmospheric carbon dioxide and temperatures in the natural world.

Focus on your school. Think about your school's ecological footprint—in other words, how many greenhouse gas emissions, particularly carbon dioxide are produced from its everyday activities. For example:

- using energy at school and for transport,
- producing the foods we eat at school and the goods and services used, and
- disposing of waste such as paper, food waste, garden waste and packaging.

Ask students to describe and summarise their understanding of emissions in energy, water, waste, transport and biodiversity contexts at the school.

Talk with the students about the many things they can do to reduce greenhouse gas emissions and improve the school's ecological footprint in the classroom. For example:

- Add or remove layers of clothing depending on how hot or cold one feels.
- Use a hand fan when hot to increase air movement.
- Use window blinds (if available) to cut down on the heating effects of the sun.
- In warm situations, use natural ventilation to cool classrooms.
- If possible, work away from direct sunlight or sources of radiant heat in summer.
- Use natural lighting whenever and wherever possible.
- Address the management of outputs that affect climate, for example, energy use, transport choices, purchasing, materials use, materials disposal.
- Use and develop the school grounds and surrounding areas to increase sequestration (carbon absorption) by planting trees and attracting native wildlife.

Can they think of other measures?

Climate change adaptation involves taking action to adjust to, or respond to, the effects of changes in climate. Talk with students about the many things we can do to adapt to changes in our climate. Discuss how each of the actions described, (both mitigation and adaptation) requires one person to make a difference.

Investigate the **Australian Youth Climate Coalition** and find out about their change-making ideas.

Water is essential for living things to survive. People need water to live, to grow food and for most manufacturing processes. Rainfall, major rivers and groundwater supplies provide water for many different purposes.

Clean water

Discover more about **people's access to clean water supplies**.

Read information from the **United Nations** about people's access to water.

Explore change makers in the western world, like engineers who have 'tamed' and treated our water. Meanwhile, people in developing countries can only envy the levels of technology those of us have who can turn on a tap or flush a toilet.

Explore the appropriate types of technology devised by change makers to enable people to access water supplies. For example, the **Rus Pump**.

Investigate other technologies like the:

- Tube Well,
- Hydraulic Ram Pump,
- Ferro Cement Water Tank, and the
- Water Jar.

Look at the features of these game-changing designs and consider: the choice of materials; the effectiveness of the technology in meeting its purposes; and how they support people to access clean water supplies.

Sanitation

Discover more about sanitation. Sanitation can be defined as access to facilities that safely and cleanly dispose of human urine and faeces.

Discuss how, globally, over 2 billion people live without this essential service, and as a result, millions of these people become sick, with diarrhoeal diseases killing almost 5,000 children a day.

Ask students to imagine a world without toilets. Watch the video **Can you imagine life without toilets?** on YouTube (1:40 min).

Research game changers and change makers like **WaterAID Australia** that have established sanitation projects in Timor-Leste.

Find out about other game changers and change makers in the **FOOTPRINTS Network** who work with **WaterAID Australia** to bring water and sanitation to a school in Papua New Guinea, and water and sanitation to countries like Cambodia.

Clean oceans

Talk about areas of our planet where oceans are facing problems or complications due to human waste, be it by deliberate dumping of waste or by natural run-off from the land.

Brainstorm or make predictions about the materials that could be found along a waterway and or in our oceans.

Research the game changers and change makers who are taking action and helping to clean up our oceans. **Boyan Slat** is a game changer who used a high school science project to drive his ideas about how to rid the oceans of plastic pollution.

Learn about the game-changing idea of a new plastics economy where plastic never becomes waste and **how we can keep plastics out of the ocean**. YouTube (3:10 min).

Discover the game-changing scientists who have discovered a **fungus that can break down plastics in weeks**.

Dream:

Ask students to visualise work samples that can educate the broader community on how how game changers and change makers advocate for a stable climate, clean water supplies, sanitary waste disposal, clean oceans, and active and informed citizens.

Ask students to imagine what their work samples might look like and how they will bring awareness to the theme 'Game Changers and Change Makers' and to the issues of climate change, access to clean water, sanitation or clean oceans.

Design:

Ask students to design their work sample.

Ask students to gather the materials, tools, and equipment needed and then design their work sample.

Deliver:

Create the work samples.

Deliver work samples to real audiences during National Science Week and discuss the issues of global environmental change and the game changers and change makers who advocate on the issues and create real change.

Share photos and students' work samples and presentations via National Science Week's online community. The Australian Science Teachers Association loves to see pictures of young people in the classroom learning, and to share photos via email at **nscwk@asta.edu.au** or share what has been created via **Facebook**, **Instagram** or **Twitter** with #scienceweek. Please ensure that you have parental permission prior to posting any images of students.

Debrief:

Ask students to recall what they learned.

Talk about what they might still like to find out about game changers and changer makers in these areas.

Identify and describe the most surprising thing they learned.

Evaluate their work sample and write about whether their work matched the definition of the task.

Ask questions like: "What would you do differently next time?"

Write about the quality of their planning, their finished work sample and whether they enjoyed the task.

Case studies

Explore these **Mind blowing innovations that are changing the world for the better** including edible water bottles, edible cutlery, eco-friendly mosquito traps, AiraWear jackets, smart jewellery, and gloves that can turn sign language into words.

Find out about a **floating bin** that can suck up plastic bags from the ocean. BBC News (0:25 min)

Links to the Australian Curriculum

Science

Years 7, 8, 9 and 10

Science as a Human Endeavour—Use and influence of science

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations ACSHE120 ACSHE135

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity ACSHE121 ACSHE136

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities ACSHE160 ACSHE194

Values and needs of contemporary society can influence the focus of scientific research ACSHE228 ACSHE230

Science as a Human Endeavour—Nature and use of science

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures ACSHE223 ACSHE226

Technologies

Years 7, 8, 9 and 10

Design and Technologies Knowledge and Understanding

Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures ACTDEK029

Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved ACTDEK040

General Capabilities:

Literacy, ICT capability, Critical and creative thinking, Ethical understanding and Personal and social capability.

Cross Curriculum Priority:

Sustainability OI.2, OI.3, OI.4, OI.5, OI.6, OI.7 and OI.8. Source: (ACARA, 2015)

Activity 5:
Eco designs

Eco architects, engineers and builders design and build structures like libraries, offices, houses, hospitals, medical centres, sport stadiums, hotels, restaurants, airports, railway stations, bus stations, shopping malls, residential areas, high-rise buildings and schools.

Eco-friendly buildings can be designed to conserve and manage water, waste and energy. Walls and roofs can be insulated to save energy. Grass roofs insulate buildings and can provide habitat for wildlife.

Eco buildings can be designed to collect rainwater for flushing toilets or watering the garden, and they can use renewable energy such as wind and solar power.

Landscape architects, engineers and builders, design and build spaces like **Green Walls** on ABC News, and **Dementia Gardens** on Vimeo (2:12 min) and parks and Indigenous landscapes like **Ngarara Place** that recognise the Aboriginal and Torres Strait Islander peoples, cultures and histories.

Use your knowledge and understanding of sustainable design and use science, technology, engineering, art and mathematics to create a new space or structure which is harmonious with the environment and evokes peace, tranquillity and restfulness.

Create posters, design and present Computer Aided Designs (CAD) designs and/or 3D models of your idea, including plant selections and discuss findings and learnings from the project with an audience during National Science Week.

Activity 6:
Possible solutions

What problem in the world would you like to solve?

Which part of your community would you like to empower?

Is there a mini STEM venture you could explore?

Be a game changer and design a book titled *STEM Manual of Big Ideas* as a school fundraiser for National Science Week.

For example:

- Organise an older family member's phone contacts on one home screen for their easy use
- Design an ideal app with **bobile**
- Design a STEM game off or online
- Create a sales pitch for a STEM idea shark-tank style.

Case study

Find out more about five free **Autism apps** developed by a 12-year-old boy from Townsville, in North Queensland.

Additional game changer and change maker activity ideas using TED Talks

Discover how a creative spark became a fully-fledged idea, became a prototype and then became an amazing invention. View the following TED talks, available on **The Inventors corner playlist**.

How new technology helps blind people explore the world (9:29 min)

Chieko Asakawa is an inventor and IBM Fellow who has been blind since the age of fourteen. She is investigating how technology can improve quality of life and navigate the world without using a sense of vision.

How I built a jet suit (7:08 min)

Richard Browning designed and built a jet suit that leans on an elegant collaboration of mind, body and technology, bringing science fiction dreams a little closer to reality. Learn more about the trial and error process behind his invention and take flight with Browning in an unforgettable demonstration.

Lifesaving scientific tools made of paper (13:58 min)

Learn about an inventor named Manu Prakash who turns everyday materials into powerful scientific devices, from paper microscopes to a clever new mosquito tracker. He also shares microscopes with students all over the world. Also, check out the **Foldscope Community** of scientists who design and create a low-cost paper microscopy platform for education purposes.

My simple invention, designed to keep my grandfather safe (5:46 min)

Hear how teen inventor Kenneth Shinozuka came up with a novel solution to help his night-wandering grandfather and the aunt who looks after him and how he hopes to help others with Alzheimer's.

Everyday inventions (14:29 min)

Meet inventor and MacArthur Fellow Saul Griffith as he shares some innovative ideas from his laboratory from 'smart rope' to a house-sized kite for towing large loads.

Discover game changers and change makers involved in tech breakthroughs

View the following TED talk, available on the **Tech breakthrough playlist**.

A headset that reads your brainwaves (10:36 min)

Meet Tan Le and her astonishing new computer interface that reads its user's brainwaves, making it possible to control virtual objects, and even physical electronics, with mere thoughts (and a little concentration). She demonstrates the headset, and talks about its far-reaching applications.

Emerging ideas for the future

Be a game changer or change maker. Develop some ideas. Develop some concepts. Develop a prototype and sell your idea as a startup.

Check out these startups below:

Orange Sky Laundry

Find out about two social entrepreneurs who began **Orange Sky Laundry** to help the homeless and who won the **Young Australian of the Year Award in 2016**.

Cows for Cambodia

Discover more about the **Cows for Cambodia** program and how cows help create sustainable lives for villagers in Cambodia.

Cloth Pads with a Cause

Find out about **Ecopads: Cloth Pads with a Cause** and the campaign to help women and girls and reduce non-biodegradable waste.

The Plasma Bin

Founders: Jack Whitehead, Josh Halliday, Aiden Molloy, Year 8 students at St. Paul's School, Brisbane.

The Plasma Bin is a waste management solution. The company aims to develop a bin that uses plasma to disintegrate waste and, in the process, generates energy from that disintegration process to power the bin itself. It thereby produces no net emissions while eliminating waste.

Little Tokyo Two: Thunder Lizard Program

Find out about **Thunder Lizards**, which is Little Tokyo Two's first entrepreneur program for high school students. Students from Brisbane State High School were the first to take part in the program.

Thankyou Water

Read about social entrepreneur Daniel Flynn who created **Thankyou.** The company was born in 2008 in response to the world water crisis. Today, Thankyou has over 40 products available in 5,000 outlets in Australia (including 7-Eleven, Coles and Woolworths). The idea was to take a more holistic approach to combating poverty, with 100% of their profits funding safe water, food and hygiene, and sanitation services around the world.

Vivify Textiles

Find out about **Vivify Textiles**, a company that makes sustainable textiles.

'Field Test': Dublin, Ireland

Explore some radical adventures in future farming.

View an exhibition of startups by the **Science Gallery Dublin** as part of the Global Science Gallery Network pioneered by Trinity College Dublin. The exhibition showcases curators and advisors from Farm Cyborgs, Farmstand Forecasts, Grow House, Ag Lab, Loci Food Lab, and Seed Boutique.

Questacon

The National Science and Technology Centre

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WORKSHOPS

Questacon also offers **free** two-hour hands-on workshops for students in Years 6–12 to immerse and engage in ideas, tools and creativity. Delivered from The Ian Potter Foundation Technology Learning Centre in Deakin, students will find inventive solutions to a range of curriculum-linked engineering, design and computing challenges. After-hours workshops are also available.

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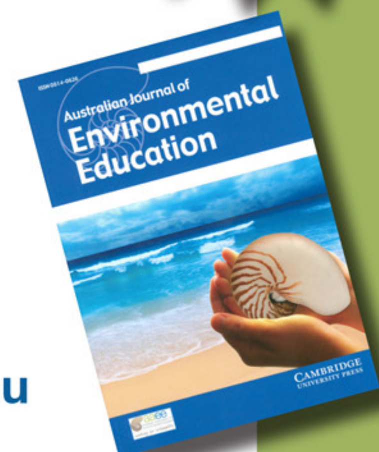

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