Department of Education
GOVERNMENT OF WESTERN AUSTRALIA

CURRICULUM RESOURCE MODULE

Assist me

YEAR 9

Acknowledgements

The STEM Learning Project respectfully acknowledges the Traditional Custodians of the lands upon which our students and teachers live, learn and educate.

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The STEM Learning Project

The aim of the STEM Learning Project is to generate students' interest, enjoyment and engagement with STEM (Science, Technology, Engineering and Mathematics) and to encourage their ongoing participation in STEM both at school and in subsequent careers. The curriculum resources will support teachers to implement and extend the Western Australian Curriculum across Kindergarten to Year 12 and develop the general capabilities.

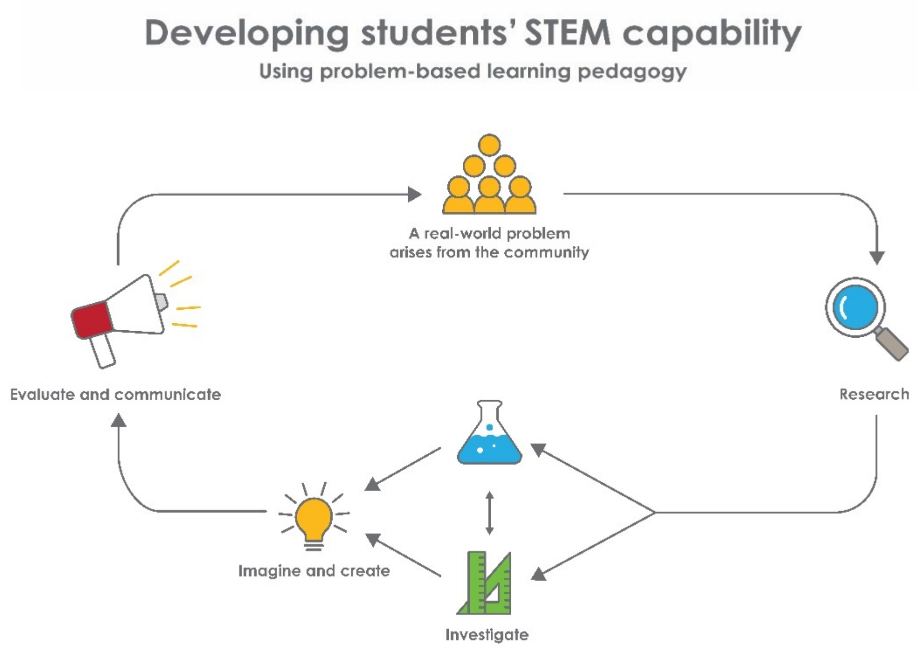
Why STEM?

A quality STEM education will develop the knowledge and intellectual skills to drive the innovation required to address global economic, social and environmental challenges.

STEM capability is the key to navigating the employment landscape changed by globalisation and digital disruption. Routine manual and cognitive jobs are in decline whilst non-routine cognitive jobs are growing strongly in Australia. Seventy-five per cent of the jobs in the emerging economy will require critical and creative thinking and problem-solving, supported by skills of collaboration, teamwork and literacy in mathematics, science and technology. This is what we call STEM capability. The vision is to respond to the challenges of today and tomorrow by preparing students for a world that requires multidisciplinary STEM thinking and capability.

The approach

STEM capabilities are developed when students are challenged to solve open-ended, real-world problems that engage students in the processes of the STEM disciplines.



STEM Consortium

Year 9 – Assist me

Overview

Assist me provides an opportunity for students to build empathy and relationships between their school and the community, including education support centres, aged care facilities or disability service providers.

A healthy learning community is characterised by strong, supportive relationships between the people within it. Educators have an opportunity to facilitate connections between students and people in the community, and to work with them to create a respectful and inclusive environment that promotes mental health and wellbeing.

Schools engaging with the community can maximise the benefits of learning opportunities for children through participation in positive learning environments outside the classroom.

What is the context?

In this module, students consider the relevance of STEM learning and the role it plays in healthcare. They learn that biomedical engineers and doctors work together to continually improve and creatively invent revolutionary devices that enable people with disabilities to complete daily life tasks efficiently and effectively. Students consider ethics, principles of social justice, and the role of technology when it comes to assistive technology.

What is the problem?

How can digital technology be used to improve the quality of life?

How does this module support integration of the STEM disciplines?

Assist me presents students with the idea of assistive technologies being used by members of the community to improve their quality of life. Students collect and collate data from a variety of members of their local community about their knowledge of disabilities and everyday challenges, and use this as a platform for developing solutions. Using the principles of design thinking, students refine and develop their ideas, evaluating and reflecting as they go. The module culminates in an advocacy event, where their ideas and solutions are presented to an authentic audience.

Science

Students begin by studying the human body at a macroscopic level, developing an understanding of how body systems work and that multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment (ACSSU175). Students identify how the nervous system relays signals between different parts of the body, with the brain interpreting these as the senses of sight, hearing and touch. Students explore the properties of waves and apply their understanding to the sense of hearing (ACSSU182). Students build empathy for others by reviewing case studies about people living with conditions that affect their quality of life.

Through a research activity, students develop understandings about other people's knowledge of disabilities, and the types of assistive technologies people may already be using. They reflect on and suggest ways to improve the quality of their data from the research activity (ACSI171). Students understand that solutions to contemporary issues are found using science and technology (ACSHE158) and that the values and needs of contemporary society can influence the focus of scientific research (ACSHE228).

Design and Technologies

Through prototype development, students explore the characteristics and properties of materials, systems, components, tools and equipment used to create designed solutions (ACTDEK046). They apply design thinking, creativity and enterprise skills (WATPPS56) as they design solutions and assess against a set of student-developed criteria, using appropriate technical terms and technology (WATPPS57). Students select and safely implement and test appropriate technologies and processes to make solutions (WATPPS58).

As students align their solution to the context of improving quality of life for individuals, they analyse the social, ethical and sustainability considerations that impact on designed solutions (ACTDEK040). They explore the development of products, services and environments, with consideration of economic, environmental and social sustainability (ACTDEK041).

Students create a design brief based on their survey data to inform their design solution (WATPPS54). Reflecting on the project, students evaluate their design processes and solutions developed against student-derived criteria (WATPPS59).

Throughout the project, students will work independently and collaboratively to manage projects, using digital technology and an iterative and collaborative approach, while also considering time, cost, risk and safety (WATPPS60).

The *Design process guide* is included as a resource to assist teachers in understanding the complete design process as developed in the Technologies curriculum.

Mathematics

Students design and utilise data collection instruments and use the information they collect to describe, interpret and represent numerical data (ACMSP282, ACMSP283). They compare this data with published data and calculate relative frequencies to estimate probabilities of events involving 'and' or 'or' (ACMSP226). Students investigate reports of surveys in digital media and elsewhere for information on how data were obtained (ACMSP227). Students identify everyday questions involving numerical and categorical variables, collect data directly and from secondary sources (ACMSP228) and when calculating values, express these using scientific notation (ACMNA210).

General capabilities

There are opportunities for the development of general capabilities and cross-curriculum priorities as students engage with *Assist me*. In this module, students:

- Develop critical and creative thinking skills as they research the problem and its context (*Activity 1*); investigate parameters impacting on the problem (*Activity* 2); imagine and develop solutions (*Activity* 3); and evaluate and communicate their solutions to an audience (*Activity 4*).
- Utilise creative thinking as they generate possible design solutions; and critical thinking, numeracy skills and ethical understanding as they choose between alternative approaches to solving the problem accessibility.
- Utilise personal and social capability as they develop socially cohesive and effective working teams; collaborate in generating solutions; adopt group roles; and reflect on their group work capabilities through self and peer evaluation.
- Utilise a range of literacies and information and communication technology (ICT) capabilities as they collate records of work completed throughout the module in a journal; represent and communicate their solutions to an audience using digital technologies in *Activity 4*.
- Communicate and, using evidence, justify their group's design to a local government councillor or community member either face-to-face, by letter or email.

What are the pedagogical principles of the STEM learning modules?

The STEM Learning Project modules develop STEM capabilities by challenging students to solve real-world problems set in authentic contexts. The problems engage students in the STEM disciplines and provide opportunities for developing higher order thinking and reasoning, and the general capabilities of creativity, critical thinking, communication and collaboration.

The design of the modules is based on four pedagogical principles:

- Problem-based learning
  All modules are designed around students solving an open-ended, real-world problem. Learning is supported through a four-phase instructional model: research the problem and its context; investigate the parameters impacting on the problem; design and develop solutions to the problem; and evaluate and communicate solutions to an authentic audience.
- Developing higher order thinking
  Opportunities are created for higher order thinking and reasoning through questioning and discourse that elicits students' thinking, prompts and scaffolds explanations, and requires students to justify their claims. Opportunities for making reasoning visible through discourse are highlighted in the modules with the icon shown here.

- Collaborative learning
  This provides opportunities for students to develop teamwork and leadership skills, challenge each other's ideas, and co-construct explanations and solutions. Information that can support teachers with aspects of collaborative learning is included in the resource sheets.
- Reflective practice
  Recording observations, ideas and one's reflections on the learning experiences in some form of journal fosters deeper engagement and metacognitive awareness of what is being learnt. Information that can support teachers with journaling is included in the resource sheets.

These pedagogical principles can be explored further in the STEM Learning Project online professional learning modules located in Connect Resources.

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Activity sequence and purpose

Activity 1

RESEARCH

Body breakdown

Students discuss the functions of the body and how degeneration, such as loss of hearing, sight or mobility, can affect people's quality of life.

They view case studies to build empathy and research possible causes of these conditions such as disease, trauma or age.

Activity 2

INVESTIGATE

Research questionnaire

Student groups create and administer a research questionnaire with a range of people in the community to identify health conditions and consequential living challenges.

Students collate and interpret data, compare this with national data sets and investigate ways to improve the quality of life for people.

Activity 3

IMAGINE & CREATE

Assistive technology prototype

Students use data to inform the development of an assistive technology solution using a design-thinking framework and makerspace approach.

Activity 4

EVALUATE & COMMUNICATE

Advocacy showcase

Students host an advocacy showcase to share their findings and solution with the community.

Students evaluate their presentation according to agreed success criteria with personal and peer reflection strategies.

Background

Expected learning	Students will be able to: 1. Describe how the values and needs of contemporary society can influence the focus of scientific research. 2. Describe how body systems function. 3. Describe how waves can explain the transfer of energy. 4. Investigate reports of surveys in digital media and elsewhere for information on how data was obtained to estimate population means and medians about people's quality of life in the community. 5. Explain how advances in scientific understanding often rely on developments in technological advances and are often linked to scientific discoveries. 6. Identify questions and issues about people's quality of life in the community and collect data directly and from secondary sources. 7. Evaluate the data and make conclusions about ways people's quality of life can be improved. 8. Work collaboratively using digital technologies to follow the design process, considering time, risk and safety. 9. Following the design process, develop a social, ethical and sustainable solution to improve a person's quality of life.
Vocabulary	This module uses subject-specific terminology, some of which is in the following vocabulary list, and contains terms that need to be understood, either before the module commences or developed as they are used: assistive technologies, biotechnology, body systems, data collection instruments, degeneration, design thinking, disability, empathy, ethical, genetic, mobility, nervous system, prototype development, prostheses, quality of life, secondary sources, scientific notation.
Timing	There is no prescribed duration for this module. The module is designed to be flexible enough for teachers to adapt. Activities do not equate to lessons; one activity may require more than one lesson to implement.

Consumable materials	A *Materials list* is provided for this module. The list outlines materials outside of normal classroom equipment that will be needed to complete the activities.
Safety notes	There are potential hazards inherent in these activities and with the equipment being used, and a plan to mitigate any risks will be required. Potential hazards specific to this module include but are not limited to: • Possible exposure to cyber bullying, privacy violations and uninvited solicitations when using the internet • Possible exposure to potentially hazardous materials and equipment • Potential manual handling hazards including slips, trips and falls and moving equipment.
Enterprise skills	The *Assist me* module focuses on higher-order skills with significant emphasis on expected learning from the general capabilities and consideration of enterprise skills. Enterprise skills include problem-solving, communication skills, digital literacy, teamwork, financial literacy, creativity, critical thinking and presentation skills. Further background is available from the *Foundation for Young Australians* article *The New Basics: Big data reveals the skills young people need for the New Work Order* (Foundation for Young Australians, 2016) *www.fya.org.au/wp-content/uploads/2016/04/The-New-Basics_Web_Final.pdf*
Assessment	The STEM modules have been developed to provide students with learning experiences to solve authentic, real-world problems using science, technology, engineering and mathematics capabilities. While working through the module, the following assessment opportunities will arise as students: • Present their solution at the advocacy event • Develop and iterate a prototype • Give and receive feedback • Self-reflect and evaluate against criteria. *Links to the Western Australian Curriculum* indicates the expected learning students will engage in as they work through the module.

Evidence of learning from journaling, presentations and anecdotal notes from this module can contribute towards the larger body of evidence gathered throughout a teaching period and can be used to make on-balance judgements about the quality of learning demonstrated by the students in the science, technologies and mathematics learning areas.

Students can further develop the general capabilities of Information and communication technology (ICT) capability, Critical and creative thinking, and Personal and social capability. Continuums for these are included in the *General capabilities continuums* but are not intended to be for assessment purposes.

Activity 1: Body breakdown

Activity focus

Students discuss functions of the body and how degeneration, such as loss of hearing, sight or mobility, can affect people's quality of life. They view case studies to build empathy and research possible causes of these conditions such as disease, trauma or age.

Background information

Approximately 20% of Australians suffer from some form of disability (AIHW, 2020), with 86% of these individuals experiencing limitations in important activities such as employment, education or self-care. These disabilities can result from diseases, degenerative conditions, or physical trauma. See *Digital resources* for a link to AIHW's report *People with disability in Australia: in brief*.

Advances in medical technology create new options for treatment and quality of life improvements for people experiencing disabilities, such as 3D printed prosthetics which can be cheaper and have more widespread access. New advances in prosthetic technology have allowed for innovative solutions such as 'energy-storing feet', 'microprocessor-controlled knees' and 'myoelectric (bionic) hands', while continually making prostheses of all kinds lighter, stronger, cheaper, and more natural in function (NeuRA, 2020). See *Digital resources* for a link to the NeuRA website.

Additionally, degenerative conditions such as Alzheimer's disease, Huntington's disease and Parkinson's disease are a focus of stem cell research and technology as a method of treatment (Lunn et al., 2011). Degenerative conditions such as these differ from disabilities caused by trauma as they worsen over time (Brain Injury Australia, 2016). In Australia, the percentage of people who experience disability is expected to rise as the population ages, in part due to the increased risk of degenerative conditions with age. See *Digital resources* for a link to Brain Injury Australia.

As new technologies are developed, they push ethical boundaries, particularly in the field of biotechnology and medical research. This is particularly true in terms of human experimentation and genetic manipulation.

Instructional procedures	The reflection journaling activities in this module encourage students to evaluate their progress and reflect on their learning. Building empathy increases students' motivation as they make an emotional connection to the module and understand the role of new advances in science and technology in the wider community. As students work through the module, they can be questioned on the importance of science and technology in the treatment of health conditions, and the value of this avenue of research compared to other topical areas of research such as climate change and space exploration. Students are encouraged to reflect on the importance of medical science and technology on an individual scale and a worldwide scale. Students develop understandings about the difficulties faced by people experiencing disabilities and are supported in creating questions to guide their research. A *random team generator* (see *Digital resources*) can be used to facilitate group work. For further information, see *Teacher resource sheet 1.1: Cooperative learning - Roles*. It is recommended that students work in the same small groups of four for all activities. This small group can be split to form pairs when required. Mixed ability groups encourage peer tutoring and collaboration in problem-solving. Collaboration is an important STEM capability. The *Neuroscience for Kids website* (see *Digital resources*) contains background information and suggested activities for use when teaching the nervous system. While this module focus on the senses of touch, sight, and hearing, additional information and activities on taste are included on this website and could be used as an extension. In this activity, students complete a two-point threshold test. The *Our sense of touch teacher guide* and the *Our sense of touch student guide* (see *Digital resources*) contain background information on this. These also include a suggested context to be used to introduce the two-point threshold test. It may be helpful to demonstrate the test before students commence the task. When students are learning about the sense of hearing, they require copies of the *Ear diagrams* to annotate (see *Digital resources*).

	It may be helpful to access the background information in the *Our sense of hearing teacher guide* (see *Digital resources*) before students conduct a class experiment on hearing.
Expected learning	Students will be able to: 1. Describe how the values and needs of contemporary society can influence the focus of scientific research (Science). 2. Investigate reports of surveys in digital media and elsewhere for information on how data were obtained, to estimate population means and medians about people's quality of life in the community (Science and Mathematics). 3. Express numbers in scientific notation (Mathematics). 4. Describe how multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment (Science). 5. Describe how the wave model can explain energy transfer through different mediums (Science).
Equipment required	**For the class:** Computer Digital projector Whiteboard or interactive whiteboard
	For the students: Digital device Reflection journal (See *Student journal*) *Student activity sheet 1.5: Two-point threshold test* *Student activity sheet 1.6: Hot and cold two-point threshold test* *Student activity sheet 1.7: Frequency hearing test* *Student activity sheet 1.8: Visualising sounds* *Student activity sheet 1.9: Reaction time test*
Preparation	Ensure students have access to digital devices for online research. Ensure students have access to the resource sheets and the websites listed in the *Digital resources* section.

Print out a range of photos that show people with disabilities (sourced from *Google* images or similar) to use as provocations for Part 8.

Activity parts

Part 1: Making sense of touch

Begin by asking the question: *What is the central nervous system?*

Working in pairs, students research on aspects of touch on the University of Washington website, including *Divisions of the nervous system*, the *Autonomic nervous system*, *Types of neurons*, *The Synapse* and *The skin* (see *Digital resources*). Students create a mind map of the key concepts of the nervous system and touch.

Student pairs join to form a group of four and discuss and compare their findings.

Conduct a class discussion where students share their research findings. Use the following prompt questions:

- Why is the sense of touch important?
- Why is it important that we can measure our sense of touch?
- When the sense of touch is activated, what does the body do with this information?

Part 2: The two-point threshold test

Students read through *Student activity sheet 1.5: Two-point threshold test*. Working in pairs, students conduct a two-point threshold test. Students determine their ability to discriminate one versus two points touching various places on the skin by measuring and recording data.

Once students have completed this activity, they move back into their group and discuss the different techniques they used. The following questions should be considered and discussed within the group:

- When taking measurements, did you start with the two points close together and increase the distance during the test, or did you start with the two points spread apart and decrease the distance during the test?
- Did you observe any difference between the two techniques?
- Did you do anything to check for consistency of the response from the subjects? For example, if the subject said they could feel two points, did you only use one

point the next time to test whether the subjects were being truthful in their responses?

Discuss the answers to the above questions as a class. Consider student findings from using different techniques when using the toothpicks and, as a class, decide if there should be a consistent approach when acquiring data of this type.

Students use their individual mean threshold values from Part A to create their personal homunculus by using *The homunculus mapper* (see *Digital resources*). Students navigate to 'Enter the results' and enter their rounded values from Part A.

The size of each body region in the homunculus is related to the density of the sensory receptors. Encourage students to consider why certain areas of their body are more sensitive than others.

Students record their responses to the following questions in their journal:

- What would happen to your sense of touch if something were to disrupt your ability to feel things, such as temperature?
- Does the temperature of our skin affect our ability to sense touch?
- Would our sense of touch heighten or diminish in hot or cold conditions?

Students read through *Student activity sheet 1.6: Hot and cold two-point threshold test*. Working in pairs, students repeat the experiment from Part A by conducting a modified two-point threshold test that uses the addition of heat packs and ice cubes to the procedure. Students determine their ability to discriminate one versus two points touching various places on the skin by measuring and recording data. However, the area of the skin being tested will be heated or cooled first.

Before conducting the two-point threshold test, students place a heat pack (which is heated as not to cause a burn) on the area to be tested for 15 seconds to heat the skin. Then, students rub an ice cube on the area to be tested for 10–12 seconds to cool the skin.

Students take three measurements during each test and for each skin area so that the mean value for both heated and cooled skin across each skin area can be calculated.

As a class, discuss how students should conduct repeated measurements. For example, should they take three measurements of the same area consecutively, or complete all the first measurements around the body, and then repeat twice more. Discuss the advantages and disadvantages of each option.

Once students have completed the heated and cooled skin two-point threshold experiment, a class discussion should be held. Students should consider any differences in measurements they may have observed and propose reasons for them. The following questions should be used to prompt student thinking:

- Why does temperature affect our ability to sense touch?
- Why does cold diminish our sense of touch, while heat enhances it?
- What are the advantages and disadvantages of temperature changing our sense of touch?
- What applications does this have in the real world?
- Where would it be an advantage to use heat or cold to alter our sense of touch?

To extend this activity, conduct a class demonstration using *Cold or Warm, Can We Really Tell?* (see *Digital resources*).

Part 3: Waves and the transfer of energy

Students work in pairs and explore the *Digital resources* section to learn about *What is a wave?* and the concepts of *Longitudinal and transverse wave motion*.

As a class, view the video *Soldiers marching in a too perfect formation* and discuss the types of wave motion being depicted (see *Digital resources*).

The whole class completes the activity *Making Mexican waves* (see *Digital resources*) before discussing the following questions:

- How does energy move in waves? Why is there no transfer of mass?
- How useful is a Mexican wave as a model of wave energy transfer and wave behaviours? In what ways could the model be improved to be more accurate?
- What other wave behaviours could be modelled using a Mexican wave? How?

Students view the video *Wave Motion* (see *Digital resources*) to learn about frequency, amplitude and wavelength.

In their groups, students complete the reading task on *Scientific Notation and Order of Magnitude* to understand the basics of scientific notation (see *Digital resources*). Once complete, the quiz from this resource should be attempted. Encourage students to consider why the scientific notation is important and where it might be used.

Students work in pairs to complete the *Scientific notation and wave mechanics study guide* worksheet to check their understanding of waves and scientific notation (see *Digital resources*).

As a class, discuss the solutions to this worksheet and consider why the understanding of waves and the use of scientific notation is important.

Part 4: Making sense of hearing

Before students commence this activity, ensure they have access to *Ear diagrams* to annotate (see *Digital resources*).

Students read *What Do Cochlear Implants and Hearing Aids Sound Like?* (see *Digital resources*) to learn about hearing basics, how hearing aids work and how cochlear implants work. Students work in their group and complete the activities on the resource.

Student groups conduct a listening experiment on themselves. Students download the *Simulation response sheet*, use the *Simulation speech answers* to score their responses and graph their results using the *Results graphing sheet* (see *Digital resources*).

Once complete, student groups discuss the following questions and record their responses in their journal:

- Which condition resulted in your highest percentage of words correct? Which condition resulted in the lowest score?
- How does listening to audio through a hearing aid and a cochlear implant change your ability to recognise speech in a noisy environment? How can you tell?

Hold a class discussion and encourage student thinking with the following question prompts:

- Why is hearing important?

- What does hearing allow us to do in our everyday world? Students need to think beyond just listening to conversations, but also consider being aware of our surroundings. For example, listening for traffic when crossing a road or knowing if something is coming up behind you (like a bicycle on a path).

As a class, or in larger groups, students use their sense of hearing to discern the location of a noise. Students then complete the *What's that noise? class experiment* (see *Digital resources*).

To observe the difference a hearing impairment can make on the ability to discern the location of a sound, the group should repeat the experiment with an earplug placed in one ear, and then both ears.

As a class, watch *How Old Are Your Ears?* (see *Digital resources*), then hold a discussion to consider the question:

- Why does hearing diminish as people get older?

Students read through *Student activity sheet 1.7: Frequency hearing test*, then individually complete their own frequency hearing test to investigate their range of hearing.

Once all students have completed their own frequency hearing test, share class results in a collaborative space. As a class, calculate the class mean for the hearing range (upper and lower frequency levels) and discuss if this is within the expected range.

Students could also have parents, grandparents or younger siblings complete the frequency hearing test at home, then bring the results back for comparison with the class results.

As a class, consider the following questions:

- Why might there be a difference in the frequency ranges heard by different aged people?
- Is there any advantage or disadvantage to being able to hear high frequencies?
- Could high-frequency sounds be used in society to benefit or disadvantage a group of people?

As a class, watch the video *How voice frequencies affect speech intelligibility* (see *Digital resources*). This will assist students to understand how different parts of speech influence our ability to understand someone talking.

Students watch *Oscilloscope frequency measurements* and *Oscilloscope questions - how to calculate time period and frequency* to understand how to use an oscilloscope to determine the period of a sound, and consequently the frequency (see *Digital resources*).

Students read through *Student activity sheet 1.8: Visualising sounds*. Working in pairs, students use a *Virtual oscilloscope* (see *Digital resources*) to visualise different sounds. They then calculate the frequency of different sounds and express these in scientific notation.

Discuss the findings of this activity as a class and ask students to reflect on the following:

- Which sounds had the highest or lowest frequencies?
- Why are some sounds harder to hear than others?
- Do you know anyone with a hearing difficulty? Do you know which sounds they have trouble hearing?
- Does hearing loss in the high-frequency range correspond to which sounds some people cannot hear?

In groups, students visualise the frequencies that make up different sample sounds using an online audio *Spectrum analyser* (see *Digital resources*).

After reading through the resource, students should analyse the range of frequencies that make up the sample sounds. They can also upload their own sound file to analyse.

Encourage students to consider the question:

- Why does a police siren only have sounds in the range up to 10,000Hz?

As a class, the *Frequency-shifted voice demo* can be used to demonstrate how voices sound when they have been frequency shifted (see *Digital resources*). A discussion will follow for students to consider where the frequency shifting of sounds could be useful.

Part 5: Shedding light on sight

Students review the anatomy of the eye by watching the *Cow's eye dissection* video (see *Digital resources*).

Students watch *The visual system: How your eyes work* video to learn how the different parts of the eye work together to allow us to see (see *Digital resources*).

Introduce students to the measurement of reaction time by explaining *The fighter pilot challenge* (see *Digital resources*).

Students read through *Student activity sheet 1.9: Reaction time test*. Working in pairs, students complete a reaction time test.

Students complete the experiment with the following variations:

- Eyes open and with a verbal warning when the ruler will be dropped (such as a countdown, or a single warning word)
- Eyes open and with the touch on the shoulder to indicate when the ruler will be dropped
- Blindfolded and given a verbal cue when the ruler will be dropped
- Blindfolded and touched on the shoulder when the ruler will be dropped.

If time permits, students also measure their reaction time while being distracted (eg reading a sentence out loud while trying to catch the ruler).

Students discuss the following questions in their groups:

- What is happening with the senses during this experiment? Draw a stimulus-response model for each of the scenarios completed in the reaction rate experiment.
- Why was the reaction time longer when you were distracted?
- How might reaction time change with age or gender?
- How might reaction time change for a person with a sensory impairment?
- Why is reaction time important?

As a class, students review near and farsightedness as they watch the video *Defects of vision and their correction - How do spectacles work?* (see *Digital resources*).

Students work in pairs and explore vision defects using the *See now – sight loss simulator* (see *Digital resources*). Students then use other vision defect simulations, including *Gaining empathy: Exploring user needs through vision simulations* and viewing a familiar address by discovering *What does being blind or visually impaired look like?* (see *Digital resources*).

As a class, discuss some of the major challenges faced by someone who has a vision defect or deficiency, and what everyday tasks or activities this could affect.

Additional learning activity

If possible, students build their own vision impairment goggles. The teacher can explore the resources on *Living with vision impairment* (see *Digital resources*) and have students wear impairment goggles for a period and try to complete daily activities within the classroom. As a class, students discuss the degree of difficulty experienced when undertaking certain tasks while wearing the impairment goggles.

Students could also impair more than one sense at a time, such as hearing and sight, to simulate multi-sensory failure.

Before students commence this activity, they require materials with which to make the glasses and copies of the *Glasses template* printed on cardboard (see *Digital resources*).

Students explore the importance of colour in our ability to discern the world around us by completing the experiment *See the world through colour-filtering lenses* (See *Digital resources*).

The Our Sense of Sight: Visual Puzzles teacher guide describes how to set up the students exploring the importance of depth perception experiment (see *Digital resources*).

Students work in groups to explore the importance of depth perception using the *Visual puzzles class experiment* (see *Digital resources*).

Students reflect on the following questions in their journals:

- What have you learnt about the importance of colour vision?
- What have you learnt about the importance of depth perception?
- What tasks could be made more difficult if you were unable to distinguish the differences between certain colours? What tasks could be made more difficult if you were unable to determine depth?
- Why is sight such an important sense to humans?

Part 6: Introduction to empathy- Moral dilemma

This task is an introduction to empathy and builds the foundation for the next tasks.

Students form groups of four to discuss the moral dilemma entitled, *The monument and the shoes.*

Jack had been living with a remote tribe for several months when the Chief of the tribe asked to speak with him in private. The Chief told Jack that he had formed a very *good bond with him and trusted him a great deal. The Chief then asked Jack to complete a request when the Chief dies.*

"I have hidden 500 gold coins under this tree, and I want you to use this money to construct a monument in my honour when I die, and I want the monument to be in the centre of the other monuments of former Chiefs. Only you know about this, so you must keep it a secret."

Jack agrees.

Several months later, the Chief dies, and Jack digs up the gold to start construction on the monument. As he is walking back to the village with the gold, he notices the children playing and remembers how many foot problems there are in the village. Jack looks at the gold and realises he has enough gold to buy shoes for all the children in the village.

Jack thinks about his dilemma and decides to spend the money on shoes. After all, no one else knows about the monument, and more people will benefit from the shoes.

Students discuss the following questions before they come back to the class with their decision and justification. Reiterate to the students that there is only enough gold to do one or the other.

- What do you think are the most important aspects of this scenario?
- Should Jack have bought the shoes, or constructed the monument?
- Is it more important to honour the Chief's request, or for Jack to make his own decision?
- What is your group's reason for this decision?

Hold a class discussion using the above questions as prompts. Explore the groups' reasoning for their decisions. Note: it is often observed that student groups will choose that the monument should be constructed.

Part 7: Building empathy

In pairs, students go on a blindfolded walk, relying on their partner to guide them. After the walk, hold a class discussion. The following questions can be used as prompts:

- How did you feel starting the walk?
- Did you trust your partner?

- How do you feel now? How do you feel about your partner? (closer/more trusting...fearful)
- What are the things you had to do because you couldn't see?

Working in pairs, students learn about physical impairments by participating in fine motor skills exercises. Each student takes a piece of paper and a pencil, and to simulate a partial loss of hand control, they write their name and address using their non-dominant hand.

Students receive a long strip of masking tape. Students tape their thumb and first two fingers to the palm of their dominant hand. They should then attempt tying their shoelace, manipulating a zipper or buttons, cutting a piece of paper with scissors, or turning a page of a book.

To simulate multiple impairments, one student in the pair will have their thumb, and first two fingers on both hands taped to their palms. Students then attempt:

- To lift a plastic cup with water
- To drink from a plastic water bottle
- To fill a plastic cup with water from a plastic jug
- To fill a plastic cup with water from a plastic jug while they have their eyes shut.

A class discussion should then consider the following:

- What made these tasks difficult?
- What kinds of devices could have helped complete these tasks?

As a class, view *Dylan Alcott – The Truth About Growing Up Disabled* (see *Digital resources*).

Set the mood for a reflection task by asking students to find a quiet place in the classroom. Ask students to reflect on the following questions in their journals:

- What would you have done in Dylan's situation? Would you have gone to the party?
- Dylan states, "*Unfortunately, there are so many kids right across the world and all-around Australia that are really struggling socially because of their disabilities. Disability really remains this thing that nobody really wants to talk about. And there is still this negative stigma that having this disability is this weird, unlucky, really ugly thing.*" What does Dylan mean by the negative stigma involved with having a disability?
- Reflecting on your own experience of people with disabilities, do you think Dylan's description of the

experience of Australian students with a disability is accurate? If so, what is one thing you could do differently to help improve the visibility and status of people with disabilities?

A visual timer can be useful for students to plan their time effectively (see *Digital resources*).

As a class, view *Things People with Disabilities Wish You Knew* (see *Digital resources*). Ask students if there was a part of the video that surprised them. Why?

Part 8: Conditions affecting the quality of life

Print out a range of photos showing people with disabilities (sourced from *Google images* or similar) to use as provocations. Set these up around the classroom at different stations, ensuring there are one for each group.

Students work in groups of three. Allocate each group a letter (eg Group A, Group B, Group C). Students decide who in their group plays each of the roles below:

- Scribe – writes down everyone's answers and confirms that people's ideas have been accurately captured
- Timekeeper – keeps track of the time to ensure the task is completed and brings people back on track if they get distracted
- Manager – makes sure everyone is contributing to the group and invites those not participating to join in.

Assign one group to each station. Students spend two minutes at each station before rotating clockwise to the next station. Display a two-minute interval timer (see *Digital resources*) in a location visible to all groups.

Ask students to reflect on the following questions and write their answers in their journals:

- Which part of the body and/or bodily function(s) were affected?
- What similarities do you observe?
- What differences do you observe?
- Pick one of the conditions and place yourself in that person's shoes. Walk yourself through some activities that you perform on a day-to-day basis. Can you think of ways your life could be affected?

Invite students to share their answers with the class.

Question the class about the types of technologies they have seen or know about that are designed to help people with disabilities or impairments. Ask:

- How do these technologies work?
- How do they make tasks easier for the person using them?
- How would their lives be different if they didn't have access to these technologies?

As a class, use internet search engines to discover examples of assistive technologies (see *Digital resources*).

Explain to students that, as they work through this module, they will design a prototype for a technological solution to improve the health and wellbeing of people from their community.

Discuss ways students could access information to assist with this task and what research activities they may organise. Record these ideas as a brainstorm.

Part 9: How technology drives scientific research

As a class, view the TED talk *Wearable Tech Expands Human Potential* by Lauren Constantini (see *Digital resources*) and discuss the following questions:

- Who has some form of wearable tech, smart device, implant or peripheral? What data (information) does it provide? How might this data help you to improve your health and wellbeing?
- Why do you think humans tend to ignore the data that our body is radiating 'until something goes terribly wrong', as Lauren puts it?
- Stereotypically, which gender do you think ignores this data (our warning signs from our body) more? Why? Do you think this is changing?
- Lauren says that users of wearable tech are removing them after six months and contends that 'they can then remove those sensors, removing the training wheels and they maintain that enriched life'. Why do you think wearable tech has the power to change human behaviour?
- How might wearable tech improve the quality of life of someone with the conditions we looked at in Part 2?
- Choose one behaviour to change for the next week to improve your health (eg improve sleep patterns, eating more healthily, drinking more water, go for a walk/run each day).
- Think about how you might use the technology you have available to improve your chances of a behavioural change. For example, using a smartwatch

to track sleep patterns, a food tracker app to watch what food you eat, a reminder on your phone to drink more water, mindfulness meditations to improve mental health. There are many free mobile phone apps available that students can download. Students with limited (or no) access to technologies could work together with a student who does.

- Keep a digital log each day of how you are going with your change.

Encourage students to continue the challenge for the rest of the module and check-in during *Activity 4*.

Students choose one of the technologies from the article *Ten top technologies that will transform the Healthcare Industry* (see *Digital resources*) or select one of their own.

Students research their technology and present answers to the following questions in a mode of their choice (eg presentation, video, poster):

- What is a layman's definition of the technology?
- How is/might the technology be used in the medical industry?
- When might we expect to see this technology being used in the medical industry?
- What improvements could this technology make to an individual's health?

Students who have chosen the same technology could be grouped to share resources and use a jigsaw strategy, particularly if they have not used an inquiry approach before. See Teacher resource sheet 1.2: Cooperative learning – Jigsaw.

On completion, students present their assessments to their class or a younger year group to help prepare them for the product showcase in *Activity 4*.

Part 10: Degeneration of the human body

There are several short activities on the Carolina Biological Supply Company website (see *Digital resources*) that look at the various systems of the human body. They are divided into three categories: Introduce, Build and Review. Some of these activities specifically talk about degeneration of the systems, others do not. Students should be prepared to justify their choice of activity, based on the inclusion of a degenerative condition.

Ask students to choose a body system that is commonly prone to degeneration. After analysing their body system, students conduct a think-pair-share activity for the following questions:

- In what way do parts of the body system they are studying fail/degenerate?
- How will this affect their health/way of life?

For the share component, distribute whiteboard markers to all pairs and have a student from each pair write the answer to the first question on a shared classroom whiteboard. If the answer as already been written, students put a tick next to that answer. Go through each answer on the board and repeat with the second question.

There are many free interactive body system websites to help students think through these questions.

Part 11: Assistive technology

Students read the World Health Organization webpage about assistive technology (see *Digital resources*).

Prompt class discussion with the following questions:

- Which statistic most surprised you?
- Read through the challenges, which challenges do you think most affect Australia? Why?

Divide students into small groups of three or four. Students investigate a range of technologies that are used for assisting people with the body systems they studied in *Part 10*.

Each group chooses one assistive technological product and researches it in detail, looking at the functional improvement the technology provides, rather than the technical aspects of how it works.

Students may like to consider technologies that assist with conditions such as:

- Poor vision
- Reduced mobility
- Diminished strength
- Impaired memory.

Students present their research to the class in a mode of their choice. This could be completed as an assessment task.

Resource sheets	*Student journal* *Teacher resource sheet 1.1: Cooperative learning – Roles* *Teacher resource sheet 1.2: Cooperative learning – Jigsaw* *Teacher resource sheet 1.3: Cooperative learning – Think-pair-share* *Teacher resource sheet 1.4: Cooperative learning roles - Placemat* *Student activity sheet 1.5: Two-point threshold test* *Student activity sheet 1.6: Hot and cold two-point threshold test* *Student activity sheet 1.7: Frequency hearing test* *Student activity sheet 1.8: Visualising sounds* *Student activity sheet 1.9: Reaction time test*
Digital resources	*People with disability in Australia: in brief* (AIHW, 2019) *www.aihw.gov.au/reports/disability/people-with-disability-in-australia-in-brief/contents/how-many-people-have-disability*
	Neura *www.neura.edu.au/*
	Brain Injury Australia *www.braininjuryaustralia.org.au/*
	Random Team Generator (Random Lists, n.d.) *www.randomlists.com/team-generator*
	Neuroscience For Kids website (E. H. Chudler, 2020) *faculty.washington.edu/chudler/neurok.html*
	Our sense of touch teacher guide (E. H. Chudler, n.d.) *faculty.washington.edu/chudler/pdf/mmtg.pdf*
	Our sense of touch student guide (E. H. Chudler, n.d.) *faculty.washington.edu/chudler/pdf/mmsg.pdf*
	Our sense of hearing teacher guide (E. H. Chudler, n.d.) *faculty.washington.edu/chudler/pdf/heartg.pdf*

	Divisions of the nervous system (E. H. Chudler, 2017) faculty.washington.edu/chudler/nsdivide.html
	Autonomic nervous system (E. H. Chudler, 2020) faculty.washington.edu/chudler/auto.html
	Types of neurons (E. H. Chudler, 2019) faculty.washington.edu/chudler/cells.html
	The synapse (E. H. Chudler, 2020) faculty.washington.edu/chudler/synapse.html
	The skin (E. H. Chudler, n.d.) faculty.washington.edu/chudler/receptor.html
	The homunculus mapper (brainmapper.org, 2020) brainmapper.org/experiment/
	Cold or Warm, Can We Really Tell? (Scientific American, 2020) scientificamerican.com/article/cold-or-warm-can-we-really-tell/
	What is a Wave? (D. A. Russell, 2015) acs.psu.edu/drussell/Demos/waves-intro/waves-intro.html
	Longitudinal and Transverse Wave Motion (D. A. Russell, 2016) acs.psu.edu/drussell/Demos/waves/wavemotion.html
	Soldiers marching in a too perfect formation (ENews, 2014) youtu.be/kZF7QC3tsJY
	Making Mexican waves (Science Learning Hub, 2011) sciencelearn.org.nz/resources/130-making-mexican-waves
	Wave motion | Waves | Physics (FuseSchool, 2017) youtu.be/CVsdXKO9xlk
	Scientific Notation and Order of Magnitude (VisionLearning, 2016) visionlearning.com/en/library/Math-in-Science/62/Scientific-Notation-and-Order-of-Magnitude/250
	Scientific Notation and Wave Mechanics Study Guide (Loudoun County Public Schools, n.d.)

	lcps.org/cms/lib4/VA01000195/Centricity/Domain/16649/SG%20QUIZ%20-%20Sci%20Not%20and%20Wave%20Mech.pdf
	Printable versions ear diagrams (ScienceFriday, 2017) sciencefriday.com/wp-content/uploads/2017/04/Printable-Versions-Ear-Diagrams.pdf
	What Do Cochlear Implants and Hearing Aids Sound Like? (ScienceFriday, 2017) sciencefriday.com/educational-resources/cochlear-implants-hearing-aids-sound-like/
	Simulation response sheet (ScienceFriday, 2017) sciencefriday.com/wp-content/uploads/2017/04/Simulation-Response-Sheet.pdf
	Spreadsheet version of the answer sheet (ScienceFriday, 2017) sciencefriday.com/wp-content/uploads/2017/04/Simulation-Speech-Answers.xlsx
	Results graphing sheet (ScienceFriday, 2017) sciencefriday.com/wp-content/uploads/2017/04/Results-Graphing-Sheet-1.pdf
	How Old Are Your Ears? (AsapSCIENCE, 2013) youtu.be/VxcbppCX6Rk
	How voice frequencies affect speech intelligibility (DPA Microphones, 2019) youtu.be/PIDz1Ov2Xuw
	Oscilloscope Frequency Measurements (Wisc-online, 2019) youtu.be/QILNwuHEu4k
	Oscilloscope Questions - How to Calculate Time Period and Frequency (GCSE Physics Ninja, 2014) youtu.be/Hil3d7OF5m4
	Virtual oscilloscope (Academo.org, 2020) academo.org/demos/virtual-oscilloscope/
	Spectrum analyser (Academo.org, 2020) academo.org/demos/spectrum-analyzer/

	Frequency-shifted voice demo (The University of Texas at Dallas, n.d.) personal.utdallas.edu/~assmann/FSHIFT/freqshiftdemo.html
	Cow's eye dissection (Exploratorium, 2010) exploratorium.edu/learning_studio/cow_eye/video.html
	The visual system: How your eyes work (National Eye Institute NIH, 2016) youtu.be/i3_n3lbfn1c
	The fighter pilot challenge: in the blink of an eye (The Open University, n.d.) open.edu/openlearn/sites/www.open.edu.openlearn/files/open2files/g-force.pdf
	Defects of vision and their correction - How do spectacles work? (BY JU's, 2019) youtu.be/F2KHaUjNHos
	See now – sight loss simulator (Seenow.org, n.d.) simulator.seenow.org/webgl-camera.html
	Gaining empathy: Exploring user needs through vision simulations (Medium, 2018) medium.com/design-intelligence/gaining-empathy-exploring-user-needs-through-vision-simulations-1a914d41d04e
	What does being blind or visually impaired look like? (The Fred Hollows Foundation, n.d.) www.hollows.org/sightsimulator/
	Activity 4A: Living with Vision Impairment (UT Health San Antonio Teacher Enrichment Initiatives, n.d.) teachhealthk-12.uthscsa.edu/activity/activity-4a-seeing-straight
	Glasses template (ScienceFriday, 2014) sciencefriday.com/wp-content/uploads/2014/01/Glasses-Template.docx

	See the world through colour-filtering lenses (ScienceFriday, 2014) sciencefriday.com/educational-resources/see-the-world-through-color-filtering-lenses/
	Our Sense of Sight: Visual Puzzles teacher guide (E. H. Chudler, n.d.) faculty.washington.edu/chudler/pdf/pertg.pdf
	Visual Puzzles class experiment (E. H. Chudler, n.d.) faculty.washington.edu/chudler/pdf/persg.pdf
	The Truth About Growing Up Disabled | Dylan Alcott | TedXYouth@Sydney (TEDx Talks, 2015) youtu.be/tvNOzJ7x8qQ
	Things People With Disabilities Wish You Knew (BuzzFeedVideo, 2018) youtu.be/_b7k6pEnyQ4
	2 Minute Interval Timer (Kai Patient, 2014) youtu.be/2dAorgAB0I4
	Wearable Tech Expands Human Potential | Lauren Constantini | TEDxMileHigh (TEDx Talks, 2014) youtu.be/FESv2CgyJag
	Ten Top Technologies That Will Transform The Healthcare Industry (Reenita Das, 2016) www.forbes.com/sites/reenitadas/2016/10/11/healthcare-2025-ten-top-technologies-that-will-transform-the-industry/#1323dfb93e18
	Human body systems (Carolina Biological Supply Company, n.d.) www.carolina.com/teacher-resources/Interactive/human-body-systems/tr40161.tr
	The Human Body (Siemans, n.d.) 35058.stem.org.uk/humanbody/index.html
	Assistive health technologies (World Health Organization, n.d.) https://www.who.int/health-topics/assistive-technology#tab=tab_1

	5 minute timer (Adam Eschborn, 2015) youtu.be/_W0bSen8Qjg
	Two minute timer (Adam Eschborn, 2015) youtu.be/4xG2aJa6UyY

Activity 2: Research questionnaire

Activity focus	Student groups design and administer a research questionnaire to members of the community to identify knowledge about health conditions and consequential living challenges. Students collate and interpret their data, compare this with national data sets and investigate ways they could make changes to improve the quality of life for these people.
Background information	The study of degenerative conditions is complex and multi-faceted, and a rigorous understanding is required to solve these problems. Good data collection is essential. The data collection instruments must be well thought out. Having comprehensive information about the issue will make the design of a solution much easier.
Instructional procedures	This section is all about building team cohesiveness. Students need to feel connected to the other people in their team and be willing to collaborate with them. Students may not have been taught effective collaboration skills and additional activities could be added to help support students. Most students already have some experience in developing guidelines for class discussion, and this can be extended into working together as a team. A shared online space to collate ideas and writing can be used as a support strategy. Introduce the idea of working to tightly controlled timelines to help focus energies. Students need to be aware of how much time they have and how best to make use of it. Extracting usable information off the internet can be difficult, and students may need support when determining which websites are reputable. For example, what is the difference between a .com and a .gov domain? Who puts the information there, and how do we know we can trust it? Students require a deep understanding of the condition to create a suitable model. Ask questions about the model to elicit responses to gather their knowledge and to help them find gaps.

	Students may need background information on the reliability of samples and why a sample may not be an accurate representation of the whole population. Explain that samples and sampling are used in many ways in the world around us. Ask students, when they hear the phrases 'taking a sample' what do they think of? Is it fair? Is it reasonable to generalise? What other data would need to be collected? In this activity, students develop understandings about how classification underlies the organisation of the data, and how we classify depends on what we want to answer. There are many ways to organise data, and the way it is organised can either highlight or mask features, which determines how the data is used or interpreted. Students also consider ethical issues in the collection and organisation of data such as privacy, integrity and acting responsibly. Draw out that while collecting data in categories may close some options, it may open possibilities that they had not thought of before. The responses from open-ended questions may be difficult to sort but give broader information. Students consider how the way a question is asked can bias responses. Students understand the appropriate use of terminology and how questions should be worded to respect that person's dignity (eg rather than an 'autistic person', using 'a person with autism'*)*. Ensure student safety is a priority when connecting with others online and in person. This could be used as a discussion point for global citizenship and cyber safety with students.
Expected learning	Students will be able to: 1. Explain how advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (Science). 2. Explain how the values and needs of contemporary society can influence the focus of scientific research (Science). 3. Identify questions and issues about people's quality of life in the community and collect data directly and from secondary sources (Mathematics).

	4. Evaluate the data and conclude the ways people's quality of life can be improved (Mathematics). 5. Use features such as mean, modality and skewness to explain who is most affected by certain conditions (Mathematics).
Equipment required	**For the class:** Access to suitable apps and logins for students (eg *Microsoft Office 365*, *Google for Education*) Access to one-point rubric examples (either digital or print) Printouts of *placemat template* Sticky notes A3 paper Materials to build physical models (see *Materials list*) Materials for displaying work in a mini showcase (eg access to power outlets, triptych boards for displaying information) Optional – Access to video conferencing tools (eg *Microsoft Teams, Skype*)
	For the students: At least one digital device per group with access to the internet Reflection journals Applications for shared documentation and communication (eg *OneNote*) Application to create a logo (eg *Canva*) If students are building a digital model, suitable drawing applications (eg *Sketchup* or *Tinkercad*), see *Drawing in the design process*.
Preparation	Ensure students have downloaded applications and have accounts set up. Prepare examples of a one-point rubric to share with students. Print out *placemat templates.* Source materials for the five chairs challenge – see

	[Materials list](#). Source materials for model creation (or let students source their own from home) – see [Materials list](#). Book a suitable room that caters for mess (eg art room, makerspace).
Activity parts	**Part 1: The five chairs challenge** Students are introduced to empathy and the design thinking process by participating in *The 5 chair challenge* (see *Digital resources*). In preparation, the teacher should access the lesson plan, print out the story cards, and gather the materials. Students work in groups of four, receive a story card, identify two needs for a user, and then design a chair especially for their user. Students then build five iterations of their design using different materials. Prompt group reflection with the following questions: • What challenges did you face when identifying needs for the user? • What was it like to create different iterations of your design? • What changes did you make to your prototypes along the way?
	Part 2: Project introduction In design thinking, *How might we…* questions are used to open up possibilities for multiple solutions. The following *How might we…* statement is a generic question to provide students with guidance on the direction of the project. However, when students move through the design thinking process, they will generate more specific *How might we…* questions that will help them empathise with their users. Introduce students to the problem: *How can digital technology be used to improve the quality of life?* Explain the challenge the students: *Your group's challenge is to create a prototype of a solution that uses technology to improve the quality of life of Australians. Your group will focus in on creating a*

solution for a medical condition, impairment, disability, or risk factor. For example, you may choose to focus on designing a solution for someone with impaired vision, hearing difficulties or arthritic fingers that will solve a problem they face in their everyday life.

Group forming

Students form groups of three or four. Depending on the context of your class, you may wish to choose the groups.

Students reflect in their journals about their commitment to the group.

- What skills do I have to offer the group?
- What will I do if I find I am getting off task?
- What will I do if others are getting off task?
- How might we best work together as a group?

Together as a group, students will:

- Come up with a plan on how this group will be successful (shared commitment pledge)
- Decide what should happen if someone is not pulling their weight within the group.

Encourage each group to create a shared online space for research. This will vary depending on the school's preferred platform. For example, if *Microsoft Office 365* is used, students could create a *OneNote* or a *Word* document where research will be stored. One student can create the document and then share it amongst the others in their group. The teacher will also need permission to view and comment on the document. The teacher may want to create a template that each student group uses to ensure consistency and that student groups cover all areas that will be assessed.

By creating a shared document, all students can work on the document simultaneously. It also means that if a student is away, other students have access to the document. The teacher can also keep track of how groups are progressing in their research.

The teacher may also suggest students use communication tools, such as *Microsoft Teams* so that students can communicate and share documents outside of class.

Students read the article *Know your terms: Holistic, Analytic, and Single-Point Rubrics* (see *Digital resources*).

As a class, students generate a shared single-point (one line) rubric, encouraging ownership over what success will look like. As many students may not have done this before, they can refer to the example in the article *Meet the Single Point Rubric* (see *Digital resources*).

Students determine what attributes success would have and describe what they look like. A class discussion, think-pair-share or brainstorm can be used to develop the attributes and associated success criteria.

Part 3: Topic of research

Each group chooses a medical condition, impairment or disability, or risk factor to research.

Within their group, students brainstorm possible ideas that they could focus on for the design solution. To provide individual accountability for this activity, use the placemat cooperative learning strategy (see *Teacher resource sheet 1.3: Cooperative learning – Placemat*) with a three-minute timer (see *Digital resources*). Students write their name on their area of the placemat. The teacher could provide the following prompts to encourage ideas:

- A risk factor that affects many Australians
- A rare condition that does not get much research
- A condition that affects students your age
- A life-threatening condition
- An impairment that affects the quality of life.

After this round of divergent thinking, each group engages in a round of convergent thinking where they discuss the ideas on the placement and reduce it to two or three likely candidates for further consideration. The criteria for choosing the candidates need to be based on their suitability for demonstrating with a model and developing a solution. For example, while it is unlikely students will be able to overcome arthritis, they may be able to design a tool to help Grandad put his slippers on.

Students then share their responses as a class by placing their placemats around the classroom. Students use the gallery walk (silent) cooperative learning strategy, where students view the ideas of the other groups to expand their thinking.

Each group choose their top three responses, voting with sticky dots or notes. Student groups take a photo of their placemat and their top three ideas and add them to their shared document. Encourage students to choose a condition that they feel strongly connected to, as this will help them stay motivated.

The groups briefly research their top three ideas to choose the one they want to research in more detail. The teacher may want to provide a time limit for this activity (suggested 15 minutes, with 5 minutes to discuss after) and encourage groups to plan how they will use this time.

At the end of the time allocated, each group should have chosen which idea they will research. Students highlight this idea in their shared document. If at any stage groups decide they do not feel a personal connection to the condition they have chosen, allow them to go back to the list and choose something that they feel connected to.

Part 4: Model creation

Students require time to research their condition in more detail so they can complete this task.

Students work in groups to create a model of how the medical condition, impairment or disability, or risk factor their group are studying impinges on the lives of the people affected by it. This means students will need a thorough understanding of how the condition affects the body. The teacher may choose to include this as a summative assessment for students. If this is the case, the teacher may want to use the one-line shared rubric method to co-determine success criteria with the students.

Students can choose how they model the condition that their group is researching. Some of the examples of what this might look like could include an interactive digital representation of the condition, a movie or animation, an A2 artwork or a physical model using recyclable parts. Encourage students to come up with their own creative ideas.

This work will form part of the product showcase in *Activity 4*. It will also be a building block for students understanding how they might create a solution to help people experiencing this condition.

Part 5: Prevalence of the condition

Students use reputable resources to determine the prevalence of the condition they are researching amongst Australians. Students then use this information to calculate an estimate for the following:

- How many Australians have the condition? How many Western Australians? How many students at this school?
- What is the ratio of Australians who (will) have the condition? (eg one in three Australians will experience cancer in their lifetime)
- Students will have to consider how data sets are represented. What value do we get from averages like mean and median? What are the differences between them, and when do we use one instead of the other?
- Combine frequencies with another data set to create an estimate (eg males who have anxiety). Why might this data be inaccurate? This is an excellent opportunity to discuss relative frequencies and ratios, particularly concerning social statistics like these.

To obtain further detail on their condition, encourage students to answer the following questions:

- How can you represent the number of Australians in each age decade that have this condition? (ie 0–9 years,10–19 years, 20–29 years, etc.)
- How can you represent the number of Australians in different ranges of weight that have this condition? (ie 40–49 kg, 50–59 kg, etc.)
- What other ways might you categorise the data to give insights into Australians affected by this condition?

This kind of data suits being displayed in a histogram or stem and leaf plot. Students should describe the implications of any features in their data such as bi-modality, skewness and spread. For example, if the age of people who suffered from a condition were one of the things measured, then ages centralised tightly around a decade of 60–70 would indicate this problem is quite specific to that age range. Bi-modality might show it is important for two age groups but less important for people in other age groups.

Students should investigate how the data was obtained and explain how this may affect the numbers. Ask:

- How do these figures compare across different populations?
- Can we account for the differences between demographics?

Students consider ethical issues in the collection and organisation of data, such as privacy, integrity and acting responsibly.

As a group, students create an infographic using an application like *Canva* to display their findings. Students present their findings to the class.

Reputable data can be obtained from the following organisations (see *Digital resources* for links):

- Australian Medical Association
- Australian Bureau of Statistics
- Australian Institute of Health and Welfare – Australia's health report
- World Health Organization - Australia
- Australian Government – Department of Health

Part 6: Research questionnaire

Explain to students they will create and administer a research questionnaire for a range of people in their community or class. The purpose of the questionnaire is to understand what is known and unknown about specific conditions, and how they can affect everyday life.

Students brainstorm what they already know (the teacher may like to use the brainstorming question activity from earlier) to gain insight into the condition and the problems faced by people affected with the condition. Ask students:

- How can we find out what we (people in our class and community) *do not* know about these conditions?

Working together, students clarify and refine questions, considering both their data collection tool (eg *Microsoft Forms*) and the nature of samples. Students decide between fixed choices or open-ended responses when planning their questions. They also consider whether the responses should be a tick, word, sentence or paragraph.

Students decide whether the answers to the questions will be recorded using numbers or words. Ask students to consider how this will affect the way they record the data and how they will be able to identify particular persons from their data. Students need to consider how the surveys will be collected and collated.

They need to distinguish between qualitative and quantitative information and how best to organise and present the data. Remind students:

Quantitative data can be counted, measured, and expressed using numbers. Qualitative data is descriptive and conceptual and can be categorised based on traits and characteristics.

Students systematically organise data to answer their questions and those of others. Questions can include:

- How much do we know about different conditions? What don't we know? Can this be measured?
- Is the data a true representation of all people in our community?
- Did your questions give you the information you wanted?
- Was there any information you weren't expecting to get?
- Could you change your questions to make sure you get the information you want?

Students sort their data into qualitative and quantitative. Quantitative data can be visualised by providing opportunities for students to publish a graphic representation of their investigations, using a spreadsheet (most survey tools can create a spreadsheet of the data) to create graphs and charts. For qualitative data, students could create an infographic using an application such as *Canva*. This can be used in the product showcase in *Activity 4*.

Part 7: Reflection

Encourage students to reflect on the following questions:

- What causes, issues or areas of public health need matter to you?
- What positive outcomes in public health and the communities do you want to help advance?
- Are there populations who you feel do not have a voice?

	• What or who do you want to advocate for? What knowledge and expertise do you need to be effective in your advocacy?
Resource sheets	*Materials list* *Drawing in the design process* *Teacher resource sheet 1.3: Cooperative learning - Placemat*
Digital resources	*The 5 chair challenge* (Hasso Plattner Institute of Design at Stanford University, 2020) dschool.stanford.edu/resources/the-5-chair-challenge
	Microsoft Office 365 www.office.com
	Google for Education edu.google.com
	Scratch – a block-based programming application scratch.mit.edu
	Tinkercad – a 3D design tool for uploading to simulations or printing using a 3D printer www.tinkercad.com
	Know your terms: Holistic, Analytic, and Single-Point Rubrics (Cult of Pedagogy, 2014) www.cultofpedagogy.com/holistic-analytic-single-point-rubrics
	Meet the Single Point Rubric (Cult of Pedagogy, 2015) www.cultofpedagogy.com/single-point-rubric
	Unity Game Engine – a 3D development platform that can be used to create games, simulations, VR/AR unity.com
	Australian Medical Association ama.com.au
	Australian Bureau of Statistics www.abs.gov.au
	Australia's health (Australian Institute of Health and Welfare, 2018) www.aihw.gov.au/reports-data/health-welfare-overview/australias-health/overview

	World Health Organization – Australia *www.who.int/countries/aus/en/*
	Health topics (Department of Health, Australian Government) *www.health.gov.au/health-topics*

Activity 3: Assistive technology prototype

Activity focus	Students use data to inform the development of an assistive technology solution using a design-thinking framework and makerspace approach.
Background information	Many health conditions make it challenging for people to perform daily living activities, such as general mobility, cleaning, engaging in conversation, operating a vehicle, eating independently, getting dressed and undressed, washing, or using the bathroom. The goal of assistive technology is to reduce the impact of these challenges. This activity focuses on digital assistive technology. Examples include smartphone voice assistants which help people with tasks like switching the room lights on and off, and internet-connected services such as *Apple Siri, Google Assistant* or *Amazon Alexa* which allow for easy access to information or IoT (Internet of Things) services. These devices are integrated with a software service that relies on an internet connection to interpret and process voice commands to control smart homes electrical appliances such as light switches, televisions or curtains. Digital assistive technology devices are also classed as physical computing as they incorporate sensors to gather data about the real world and respond accordingly. For example, some smartwatches include a fall detection feature, which can automatically call emergency services if the watch detects that the wearer has fallen and does not get up. See also *Microsoft Seeing AI* smartphone app (see *Digital resources*) which uses a smartphone camera to interpret, describe and narrate the world around the user.
Instructional procedures	In this activity, students create a digital assistive technology as a digital framework/mock-up or a working prototype. Students engage in design thinking methodology, which is part of both the Digital and Design & Technologies curriculum. The [Design process] is a series of steps that guides the development of a solution to a problem. The solution should always be informed on gathering user information, and the solution developed depending on that need and application.

The core steps in the process are the same, whether applied in different contexts such as engineering or software design. These steps are:

- Define the problem: What is the need?
- Research and gather information.
- Analysis: Imagine: Brainstorm ideas.
- Ideation: Plan: Pick the best idea. How will it work? Draw a diagram, identify materials or tools required.
- Development/ production: Create: Build the solution and test it.
- Evaluation: Improve: What works, what doesn't, what could work better? Repeat the cycle.

The design process is both cyclical and iterative, and students should be encouraged not to focus on a single idea, especially at the start. It is unlikely that their first idea will be their best.

Students will display negotiation, critical thinking and reasoning skills as they work on their designs. Problem-solving in collaborative situations is a STEM capability that students need to develop. Allowing students to negotiate amongst themselves will encourage the improvement of this skill.

Students often find developing an authentic product or prototype that customers would want can be quite challenging. Typically, many assumptions are made about the end-user of the product that is not based on any factual evidence. Questioning can challenge presumptions. Questions such as, *How do you know that? Have you checked that with the user? Is that a guess or do you know that for sure?* will help students better understand the user. Making some assumptions is ok, but those should be tested by testing a prototype on the user.

The statement *How might we…?* is important to show that the solution suggested is not final and encourages the use of the design process to think of all the possibilities and choose the best idea to trial and test first.

Recognise that to design an electronic or digital system in the real world requires a level of electrical and software engineering that may or may not be a skill for Year 9 students. However, if students feel competent using physical computing platforms such as *micro:bit*, *Raspberry Pi* or *Arduino* to bring their ideas into reality, then they should be encouraged to do so.

	In the case of more adventurous or ambitious digital solutions which cannot be produced in a classroom environment, students may elect to supplement their physical mock-ups with animation or interactive software to demonstrate their approach. For example, the most recent version of the popular programming language *Scratch* includes a video sensing feature which can respond to movement in the camera's field of view. One possible application of this might be the development of an alert system for slips, trips or falls. Students continue to populate physical or digital portfolios or journals from previous activities to contribute towards a greater body of work for later assessment. This may take the form of research work, photos, digitally produced flow charts, digital framework/mock-ups or a working prototype. The Skills of the Modern Age have a Rapid Design Sprint Kit, a set of canvases that can be used with the design thinking process. These are available under Creative Commons that organisations are free to use under attribution. See *Digital resources* for links. Depending on your timeframe, students could work through a variety of these canvases. This module picks out a few that might help guide students for this particular project.
Expected learning	Students will be able to: 1. Work collaboratively using digital technology to follow the design process, considering time, risk and safety (Technologies).
Equipment required	**For the class:** Access to the Rapid Design Sprint Kit (see *Digital resources*) 40-second interval timer (see *Digital resources*) Sticky notes Markers (for Crazy 8s) Equipment and materials to develop prototypes – if the school does not have a makerspace, the teacher may want to consider the items in the *Materials list*.
	For the students: A3 paper (students to fold into 8)

	A range of markers (one per person) *Student activity sheet 3.1: Design brief*
Preparation	Ensure students have access to the *Rapid Design Sprint Kit.* Prepare a 40-second interval timer (see *Digital resources*). Organise a suitable space in the school where students can make their prototypes (typically an art/craft room or technologies room). Source materials and equipment for students to build prototypes. Ensure students know how to use all equipment.
Activity parts	**Part 1: Understanding the user** Students draw on the knowledge they have gained through their research about people affected by trauma, degenerative disease or other medical conditions to develop a thorough understanding of the user of their product. Students identify the experience required, what they are trying to achieve and develop some ideas on how they might solve the user's problem. Explain to students that it is ok to make assumptions given their understanding of the user; however, they should use the knowledge gained from data analysis in *Activity 2* to explore the range of variables. Students build empathy with the user's current situation by understanding how the condition affects daily tasks. This can be developed through comparison to non-assisted functions. A T-chart could be a useful tool for students to organise their ideas. For example, a person with shoulder mobility issues may use a sensor to lower their clothesline when hanging up and taking down washing. Divergent thinking scenarios are explored as students write as many *How might we* statements to develop a solution that meets the customer's need. Allow students some time for each group to discuss which *How might we…* statement they will use.
	Part 2: Idea generation Set up the 40-second interval timer (see *Digital resources*). Using a piece of A3 piece of paper folded into eight,

students undertake a rapid prototype approach to generate eight ideas every 40 seconds by drawing a picture that represents their idea in each rectangle.

The rapid prototype approach steps:

- Students generate ideas based on their *How might we…* statement they have chosen for their group.
- Remind students that solutions should meet the criteria of the project (a technological solution, either digital or physical).
- Each student represents an idea using a picture (not words) in the rectangle marked Idea 1.
- Every 40 seconds, students continue to generate new ideas until all eight rectangles are full.

Students may reach a point where they find it difficult to generate new ideas. In that case, they can:

- Think of an idea that will help the people that support the person affected take better care
- Take one idea and make it better
- Take two of your ideas and merge them.

Debrief students with the following questions:

- What was the most challenging part of the activity?
- If I had asked you to create eight ideas in five minutes, do you think you would have achieved it? Why? Why not?
- Are your ideas varied or similar? Why is that?

Part 3: Idea development

Using a defined set of success criteria developed by the class, students rate each other's ideas to decide which are the most impactful to the user need. In groups, students discuss which idea would be developed further to be their 'one big idea', based on their confidence to create that solution.

Each student chooses their two best ideas, then reflects on them to further develop a *How might we…* statement and product name for each of the two solutions.

Students then move back into their groups and sell their two ideas to their group members in a *Shark Tank* style one-minute elevator pitch for each product. Provide students with two minutes to prepare. Students rotate around the group clockwise until each member has presented both their ideas.

Using the 'What ideas have the most potential?' canvas, students gather the ideas that all of their group members generated and map them to the matrix of 'Impact if we get it right' vs 'Confidence of getting it right'. Ideas to the top right of the canvas (high impact and high confidence) are ideally going to be the most successful ideas.

Students in their group should then refine their focus (convergent) to 'What is our one big idea?' and flesh it out in more detail. Students test what they already know about the desirability, feasibility and viability of their idea and discover what else they need to find out.

Part 4: Storyboarding

Groups develop their idea into a prototype by defining what their product is, testing any risky assumptions and describing how the user will experience it.

Using a storyboard approach, students depict the user experience of the prototype to show the sequence of user experience. Each square of the storyboard canvas should be a visual representation (not words) of the user experience.

If students are unfamiliar with storyboarding, there are many instructional videos online to provide support, such as *Intro to Storyboarding* (see *Digital resources*).

Student groups present their storyboards to the other teams to gather feedback on the product in the form of clarifying questions.

Each team should write at least one clarifying question down on a sticky note after each presentation. The clarifying questions do not have to be answered by the student group on the spot; they may answer "*We are not sure at this stage, but thanks for the question*".

Part 5: Prototyping

Prototypes are iterations of developing a product. Encourage students to think about the quickest and easiest way to test their ideas so they can gather feedback on the product to improve it.

Using the feedback gathered, student groups iterate their prototype using a makerspace framework. Depending on the feedback, they may need to go back to different parts of the design process and re-engage with some of the detail.

	Allow students enough time to iterate and encouraging students to get feedback in between each iteration and adapt accordingly. Ideally, as each prototype is developed, the product should become more refined and better meet the customer needs. Students may use Student activity sheet 3.1: Design brief to assist with and document this process.
	Part 6: Reflection Encourage students to reflect on the process of the prototyping stage: • What did my group do well today? • What could my group do differently next lesson to collaborate in a better way? • What was the most challenging part of today's activity? • What was one big win my group had today?
Resource sheets	Student activity sheet 3.1: Design brief
Digital resources	*Rapid Design Sprint Toolkit* (Skills of the Modern Age, 2018) skillsofthemodernage.com.au/tools/rapid-design-sprint-toolkit/ Persona canvas, page 9 Empathy canvas, page 10 Point of view canvas, page 11 How might we canvas, page 12 Crazy 8s canvas, page 13 Idea ranking canvas, page 14 Idea sketch canvas, page 15 Assumptions canvas, page 16 Lean plan canvas, page 17 Storyboard canvas, page 19
	Microsoft Seeing AI smartphone app www.microsoft.com/en-us/ai/seeing-ai
	…the 4th Word (Deep Design Thinking, 2014) www.deepdesignthinking.com/deep-design-thinking/the-4th-word

	TAG Feedback Sentence Starters *nepristore.blob.core.windows.net/sessiondocs/doc_6e22ed17-60e8-41e5-8dcc-1e7d80534b49.pdf*
	40 second interval timer (Kai Patient, 2014) *youtu.be/G-JSdCqai1Q*
	Boost your creativity with eye movement (Scientific American, 2009) *www.scientificamerican.com/podcast/episode/boost-your-creativity-with-eye-move-09-11-10/*
	Intro to Storyboarding (RocketJump Film School, 2016) *youtu.be/RQsvhq28sOI*

Activity 4: Advocacy showcase

Activity focus

Students host an advocacy showcase to share their findings and solution with the school community.

Students evaluate their presentation according to agreed success criteria with personal and peer reflection strategies.

Background information

The word 'advocate' has been in use since ancient times and comes from the Latin word 'advocare' meaning 'to be called to stand beside'. To advocate for another person is to speak up for them, to give them a voice.

Public health advocacy encompasses many strategies, including communication, negotiation, argumentation, consensus and debate to advance public policies, initiatives and services in the pursuit of improved health and wellbeing.

The advocacy showcase develops authenticity for the student groups and encourages their voices to be heard.

By putting students in charge of the showcase, they not only develop important event management skills, but they are also in charge of advocating for their products. Students understand that by bringing attention to issues, it is possible to advocate and effect change.

Although advocacy can take on many forms, always at its core is the aim to influence policy to better the lives of individuals and communities.

In industry, showcase events are an important opportunity for healthcare leaders to share with legislators how their products are improving patient safety and enhancing quality care while reducing healthcare costs.

The showcase of the *Children's Environment and Health Local Government Policy Awards* highlight Local Western Australian Governments who have embraced and included children in their decision-making processes, to prioritise the health and wellbeing of children and demonstrate innovation within their policies. *See Digital resources* for the website link.

Instructional procedures

The preparation and management of the showcase should be the students' joint responsibility. This will give students

	agency over their learning and help foster critical analysis. With guidance, they will be required to make value judgements and develop skills in negotiation and conflict resolution as they navigate the event. There needs to be a framework around the showcase as it is likely that the students will have limited experience of preparing such an event. It is important that students must have a chance to showcase their work to an authentic audience. Students should understand that the quality of data they receive from their research questionnaire will be dependent on the questions they ask. Develop and peer-review the strategy and questions before the event to ensure the data will be useful. The project reflection is arguably the most important of all the tasks in the project and where the real consolidation of deep learning transpires. The meta-learning aspect of the reflection process helps students to understand what they have learnt and the learning processes. The showcase is a celebration of student learning. The more authentic the audience is, the more students will be engaged in the project.
Expected learning	Students will be able to: 1. Explain how advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (Technologies). 2. Describe how the values and needs of contemporary society can influence the focus of scientific research (Science).
Equipment required	**For the class:** Access to a digital forms application such as *Microsoft Forms* or *Google Forms* Product feedback forms (or access to the database)
	For the students: Collection of all the prototypes created through the project Reflection journals

Preparation

Ensure students have access to a digital forms application such as *Microsoft Forms* or *Google Forms*.

Activity parts

Part 1: Advocacy showcase preparation

As advocacy means different things to different people, it is important to discuss some of the way's advocacy can be described.

Ask students:

- What do you know about advocacy?
- Have you seen or been involved in any advocacy campaigns?
- What did you notice?

Explain that advocacy involves actions that lead to a selected goal or policy and is one of many possible strategies or ways to address an issue. Advocacy is not a direct service and does not necessarily involve confrontation or conflict; however, it may involve working against entrenched values, structures and customs. The effects of advocacy can be immense and allow people to have a voice and be heard on issues that affect them and the people around them.

The goal of any advocacy program is to influence policy. Therefore, it is essential to understand what policy is. A policy can be a solution, an opportunity, a chance to problem-solve, make a change, or create a framework.

Ask students:

- What do you know about policy?

A policy is a planned course of action that links problems to solutions, and advocacy is all about generating solutions. A policy provides a guide which informs people of how something should be carried out and the expected result.

Policy change through advocacy is required for many reasons, such as when basic needs are not being met, people are not being treated fairly, or they do not reflect public health risks.

Explain that advocacy is best used when you want to:

- Promote public health objectives
- Overcome barriers that restrict public health opportunities
- Promote the importance and relevance of prevention

- Ensure a better quality of life
- Be responsive to needs but be balanced with providing innovative, proactive strategies
- Be oriented towards outcomes for public health
- Aim for the empowerment of disadvantaged individuals and groups
- Challenge stereotypes and stigma.

Students consider the following as a framework when planning their campaign:

- What is the problem? At its core, what is the issue that is causing a problem?
- What is the effect? How does the issue affect the individual, community or country as a whole?
- What is your policy solution? What can be changed to prevent or limit the effects of the problem and improve the wellbeing of your community?

Holding the showcase to promote an advocacy goal is a great way to generate interest. Students may consider the following regarding the preparation of the event:

How will the event be managed?

- Students manage the whole event with little input.
- Students elect leaders to take on roles to manage various parts, and then other members elect to join teams.
- Students work in their student groups and elect to look after one aspect of the showcase, and a leader from each group meets to share with the other groups.

Location

- When will the event take place? What permissions will be required by the school to hold the event? Who else will need to attend?
- Where will the event be held? At school or outside of school? Is there already an existing event that the showcase could be added to?
- What facilities does the venue have? What else will be required?
- How will the showcase be laid out? Which team will be allocated to which space? What are each team's requirements for their space?
- How will you transport items and students to the location?

Attendees

- Who will attend the event? From school? From outside the school? Will there be an open invitation to the community? Medical industry?
- Who will create the invitations/media posts?
- Who might you invite to critique your ideas/be judges?
- Will you invite the media (local newspapers, TV, radio, school marketing team) to attend?
- How will you know who is coming? When and how will they need to RSVP?
- Will you provide catering?

Event schedule and run sheets

- How will the event run?
- Who will do what at what time (run sheet)?
- Will there be any formalities/speeches?
- Will you require any music/videos/slides?

Assessment and feedback

- How will you assess the showcase?
- Will you use external judges, judges from the school or student judges?
- Will you have feedback forms? Will they be digital or printed? Will they be standardised amongst teams or created by each team?

Part 2: Developing feedback forms

Students consider the following when developing their feedback tool:

- How is success measured? What indicators will be in place to determine success?
- How will it be done? What strategies will be used to achieve what it is you want to do?
- What do you want to do? What is your aim, advocacy asks and outcomes?

Students may consider the following when developing their tool to measure progress:

- Surveys - print, or online questioning that gathers advocacy stakeholder perspectives or feedback
- Observation - of the event to gain firsthand experience and data
- Polling - interviews with a random sample of advocacy event guests to gather data on their knowledge, attitudes, or behaviours

- Focus or discussion groups - facilitated discussions with advocacy stakeholders to obtain their reactions, opinions, or ideas.

Explain that combining methods of gathering data will provide the most robust evaluation.

As a class, decide whether the feedback tool will be standardised across the class or be individual to each product. Discuss the pros and cons of each approach.

The feedback form can be created using an application such as *Microsoft Forms* or *Google Forms* so that data can be collected electronically. Manual print outs can work too, and students can manually collate the data themselves.

The single-point rubric developed earlier will help guide self-assessment.

Discuss assessment and whether the rubric covers every way in which students think they should be assessed. Ask students:

- Are there additional items that were not included in the rubric that should be included now?

Ask which questions should be closed questions/open questions, numeric or written feedback etc (quantitative vs qualitative data). Remind students of the value of each and the importance to collect both.

Run trials of the feedback forms in class as students judge each other's work. Check that the questions and the data are what they expect.

Part 3: Product showcase

The layout of the showcase will depend on the space students require and resources available. Consider:

- Seating and desk placement
- Showcase aesthetics such as lighting, music and branding
- Heating/cooling and refreshments
- Name tags
- Creative displays - what will your group need? Can you demonstrate your solution strategically?
- How will the event be captured? Will there be photographers?

Ensure students consider the placement of feedback forms in their showcase.

Part 4: Project reflection

The reflection is the most important part of the learning process as it allows students to define what worked well, what could have been different and how to learn from those experiences.

Reflective practice has huge benefits in increasing self-awareness, which is a key component of emotional intelligence, and in developing a better understanding of others. Reflective practice can also help in developing creative thinking skills and encourages active engagement in work processes.

Explain to students that there are three main benefits of self-reflection:

- Strengthening emotional intelligence - when taking time to self-reflect you are looking inwards
- Acting with integrity - becoming clear on your core values will help to strengthen your integrity and lead you to better decisions
- Being more confident - the more you reflect on your strengths and how you can build upon them, the more confident you will be in the future.

Student activity sheet 4.1: Presentation review, *Student activity sheet 4.2: Ladder of feedback*, *Teacher resource sheet 4.3: Evaluation* and *Student activity sheet 4.4: Self-evaluation* can be used to support reflective practice.

Students review the product feedback forms to determine the overall success of the product.

Formalise this process by asking each group to summarise the feedback they received and present it to the class.

Part 5: Journal entry

Ask students to consider the following questions in their reflective journals:

- At the beginning of the project, you were asked to commit to the group. Did you live up to your commitment? Why or why not? Be honest with yourself.
- Your group committed to working together. What score would you give to your team out of 10 for their ability to collaborate throughout the project? Did that score change throughout the project? Why or why not?
- How successful was your final solution in meeting the customer need? Do you think you could successfully develop this product?

	• Given the feedback that you received about the product, how might you adapt the product moving forward? • What was the most challenging part of this project? • What was one skill that you improved on during this project? • What were you surprised to learn during this project? • Do you think that we, as a class, made a difference during this project? Why? Why not? How might we make more of a difference next time? Ask students to complete *Student activity sheet 1.0: Journal checklist*.
Resource sheets	*Student activity sheet 1.0: Journal checklist* *Student activity sheet 4.1: Presentation review* *Student activity sheet 4.2: Ladder of feedback* *Teacher resource sheet 4.3: Evaluation* *Student activity sheet 4.4: Self-evaluation*
Digital resources	*Children's Environment and Health Local Government Policy Awards* (Public Health Advocacy Institute of WA, n.d.) *www.phaiwa.org.au/local-government-report-card-project/*
	Microsoft Forms *forms.office.com*
	Google Forms *www.google.com.au/forms/about*

Appendix 1: Links to the Western Australian Curriculum

The *Assist me* module provides opportunities for developing students' knowledge and understandings in science, technologies and mathematics. The table below shows how this module aligns to the content of the Western Australian Curriculum and can be used by teachers for planning and monitoring.

Assist me Links to the Western Australian Curriculum	ACTIVITY			
	1	**2**	**3**	**4**
SCIENCE				
SCIENCE UNDERSTANDING				
Biological sciences: Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment (ACSSU175)	●			
Physical sciences: Energy transfer through different mediums can be explained using wave and particle models (ACSSU182)	●			
SCIENCE AS A HUMAN ENDEAVOUR				
Nature and development of science: Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE158)		●		●
Use and influence of science: Values and needs of contemporary society can influence the focus of scientific research (ACSHE228)	●	●		●
SCIENCE INQUIRY SKILLS				
Evaluating: Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS171)	●	●		

Assist me Links to the Western Australian Curriculum	ACTIVITY			
	1	**2**	**3**	**4**
DESIGN AND TECHNOLOGIES				
KNOWLEDGE AND UNDERSTANDING				
Technologies and society: Social, ethical and sustainability considerations that impact on designed solutions (ACTDEK040)			●	
Technologies and society: Development of products, services and environments, with consideration of economic, environmental and social sustainability (ACTDEK041)			●	
Engineering principles and systems: Characteristics and properties of materials, systems, components, tools and equipment used to create designed solutions (ACTDEK046)			●	
PROCESS AND PRODUCTION SKILLS				
Creating solutions by investigating and designing: Identify and define the needs of a stakeholder, to create a brief, for a solution (WATPPS54)		●		
Creating solutions by designing: Apply design thinking, creativity and enterprise skills (WATPPS56)			●	
Creating solutions by designing: Design solutions assessing alternative designs against given criteria, using appropriate technical terms and technology (WATPPS57)			●	
Creating solutions by producing and implementing: Select, and safely implement and test appropriate technologies and processes, to make solutions (WATPPS58)			●	
Creating solutions by evaluating: Evaluate design processes and solutions against student-developed criteria (WATPPS59)				●
Creating solutions by collaborating and managing: Work independently, and collaboratively to manage projects, using digital technology and an iterative and collaborative approach. Considers time, cost, risk and safety (WATPPS60)		●	●	●

Assist me Links to the Western Australian Curriculum	ACTIVITY			
	1	**2**	**3**	**4**
MATHEMATICS				
NUMBER AND ALGEBRA				
Real numbers: Express numbers in scientific notation (ACMNA210)	●			
STATISTICS AND PROBABILITY				
Data representation and interpretation: Calculate relative frequencies from given or collected data to estimate probabilities of events involving 'and' or 'or' (ACMSP226).		●		
Data representation and interpretation: Identify everyday questions and issues involving at least one numerical and at least one categorical variable, and collect data directly and from secondary sources (ACMSP228)	●	●		
Data representation and interpretation: Investigate reports of surveys in digital media and elsewhere for information on how data were obtained to estimate population means and medians (ACMSP227)	●			
Data representation and interpretation: Construct back-to-back stem-and-leaf plots and histogram and describe data, using terms including 'skewed', 'symmetric' and 'bi modal' (ACMSP282)		●		
Data representation and interpretation: Compare data displays using mean, median and range to describe and interpret numerical data sets in terms of location (centre) and spread (ACMSP283)	●	●		

Further information about assessment and reporting in the Western Australian Curriculum can be found at *k10outline.scsa.wa.edu.au/home*.

Appendix 1B: Mathematics proficiency strands

Key ideas

In Mathematics, the key ideas are the proficiency strands of understanding, fluency, problem-solving and reasoning. The proficiency strands describe the actions in which students can engage when learning and using the content. While not all proficiency strands apply to every content description, they indicate the breadth of mathematical actions that teachers can emphasise.

Understanding

Students build a robust knowledge of adaptable and transferable mathematical concepts. They make connections between related concepts and progressively apply the familiar to develop new ideas. They develop an understanding of the relationship between the 'why' and the 'how' of mathematics. Students build understanding when they connect related ideas, when they represent concepts in different ways, when they identify commonalities and differences between aspects of content, when they describe their thinking mathematically and when they interpret mathematical information.

Fluency

Students develop skills in choosing appropriate procedures; carrying out procedures flexibly, accurately, efficiently and appropriately; and recalling factual knowledge and concepts readily. Students are fluent when they calculate answers efficiently, when they recognise robust ways of answering questions, when they choose appropriate methods and approximations, when they recall definitions and regularly use facts, and when they can manipulate expressions and equations to find solutions.

Problem-solving

Students develop the ability to make choices, interpret, formulate, model and investigate problem situations, and communicate solutions effectively. Students formulate and solve problems when they use mathematics to represent unfamiliar or meaningful situations, when they design investigations and plan their approaches, when they apply their existing strategies to seek solutions, and when they verify that their answers are reasonable.

Reasoning

Students develop an increasingly sophisticated capacity for logical thought and actions, such as analysing, proving, evaluating, explaining, inferring, justifying and generalising. Students are reasoning mathematically when they explain their thinking, when they deduce and justify strategies used and conclusions reached, when they adapt the known to the unknown, when they transfer learning from one context to another, when they prove that something is true or false, and when they compare and contrast related ideas and explain their choices.

Source: ACARA - *www.australiancurriculum.edu.au/f-10-curriculum/mathematics/key-ideas/?searchTerm=key+ideas#dimension-content*

Appendix 2: General capabilities continuums

The general capabilities continuums shown here are designed to enable teachers to understand the progression students should make with reference to each of the elements. There is no intention for them to be used for assessment.

Information and communication technology (ICT) capability learning continuum

Sub-element	Typically by the end of Year 6	Typically by the end of Year 8	Typically by the end of Year 10
Create with ICT **Generate ideas, plans and processes**	use ICT effectively to record ideas, represent thinking and plan solutions	use appropriate ICT to collaboratively generate ideas and develop plans	select and use ICT to articulate ideas and concepts, and plan the development of complex solutions
Create with ICT **Generate solutions to challenges and learning area tasks**	independently or collaboratively create and modify digital solutions, creative outputs or data representation/transformation for particular audiences and purposes	design and modify simple digital solutions, or multimodal creative outputs or data transformations for particular audiences and purposes following recognised conventions	design, modify and manage complex digital solutions, or multimodal creative outputs or data transformations for a range of audiences and purposes
Communicating with ICT **Collaborate, share and exchange**	select and use appropriate ICT tools safely to share and exchange information and to safely collaborate with others	select and use appropriate ICT tools safely to lead groups in sharing and exchanging information, and taking part in online projects or active collaborations with appropriate global audiences	select and use a range of ICT tools efficiently and safely to share and exchange information, and to collaboratively and purposefully construct knowledge

Critical and creative thinking learning continuum

Sub-element	Typically by the end of Year 6	Typically by the end of Year 8	Typically by the end of Year 10
Inquiring – identifying, exploring and organising information and ideas **Organise and process information**	analyse, condense and combine relevant information from multiple sources	critically analyse information and evidence according to criteria such as validity and relevance	critically analyse independently sourced information to determine bias and reliability
Generating ideas, possibilities and actions **Imagine possibilities and connect ideas**	combine ideas in a variety of ways and from a range of sources to create new possibilities	draw parallels between known and new ideas to create new ways of achieving goals	create and connect complex ideas using imagery, analogies and symbolism
Generating ideas, possibilities and actions **Seek solutions and put ideas into action**	assess and test options to identify the most effective solution and to put ideas into action	predict possibilities, and identify and test consequences when seeking solutions and putting ideas into action	assess risks and explain contingencies, taking account of a range of perspectives, when seeking solutions and putting complex ideas into action
Reflecting on thinking and processes **Transfer knowledge into new contexts**	apply knowledge gained from one context to another unrelated context and identify new meaning	justify reasons for decisions when transferring information to similar and different contexts	identify, plan and justify the transfer of knowledge to new contexts

Personal and social capability learning continuum

Sub-element	Typically by the end of Year 6	Typically by the end of Year 8	Typically by the end of Year 10
Social management **Work collaboratively**	contribute to groups and teams, suggesting improvements in methods used for group investigations and projects	assess the extent to which individual roles and responsibilities enhance group cohesion and the achievement of personal and group objectives	critique their ability to devise and enact strategies for working in diverse teams, drawing on the skills and contributions of team members to complete complex tasks
Social management **Negotiate and resolve conflict**	identify causes and effects of conflict, and practise different strategies to diffuse or resolve conflict situations	assess the appropriateness of various conflict resolution strategies in a range of social and work-related situations	generate, apply and evaluate strategies such as active listening, mediation and negotiation to prevent and resolve interpersonal problems and conflicts
Social management **Develop leadership skills**	initiate or help to organise group activities that address a common need	plan school and community projects, applying effective problem-solving and team-building strategies, and making the most of available resources to achieve goals	propose, implement and monitor strategies to address needs prioritised at local, national, regional and global levels, and communicate these widely discuss the concept of leadership and identify situations where it is appropriate to adopt this role

Further information about general capabilities is available at *k10outline.scsa.wa.edu.au/home/p-10-curriculum/general-capabilities-over/general-capabilities-overview/general-capabilities-in-the-australian-curriculum*

Appendix 3: Materials list

Equipment

- Glue guns
- Soldering irons
- 3D printers
- Laser cutters
- Cutting equipment
- Woodwork/metalwork/plastic equipment
- Sewing machines

Materials

- Craft materials
- Woodwork/metal/plastic material
- Fabrics
- Recyclable materials (cardboard, plastic, metal containers)
- Toothpicks, pipe cleaners, straws, wooden sticks, paper clips
- Rulers and metre rulers
- Graph paper
- Corks or plasticine (modelling clay)
- Heat packs and ice cubes
- Sticky tape, masking tape, scissors
- Coloured cellophane, including blue, red and green
- Vaseline and wax paper
- Plastic or paper cups

Digital (optional)

- Computers, laptops or mobile devices for creating device firmware
- Physical computing devices and controllers (eg *Makey Makey, micro:bit, Code Bug, LilyPad, Raspberry Pi, Arduino*)
- Additional peripherals such as sensors, motors, servos and power supplies
- Access to internet-connected automation services such as *If This Then That*

Appendix 4: Design process guide

Research

Finding useful and helpful information about the design problem.

Gathering information, conducting surveys, finding examples of existing solutions, testing properties of materials, practical testing.

Analysis

Understanding the meaning of the research findings.

Analysing what the information means, summarising the surveys, judging the value of existing solutions, understanding test results.

Ideation

Idea generation – turning ideas into tangible forms so they can be organised, ordered and communicated to others.

Activities such as brainstorming, mind mapping, sketching, drawing diagrams and plans, collecting colour samples and/or material samples and talking through these ideas can help to generate fu creative ideas.

Using the **SCAMPER** model can assist with this:
www.mindtools.com/pages/article/newCT_02.htm

www.designorate.com/a-guide-to-the-scamper-technique-for-creative-thinking

Development

Development of the design ideas. Improvements, refinements, adding detail, making it better.

Activities such as detailed drawings, modelling, prototyping, market research, gaining feedback from intended user, further research – if needed – to solve an issue with the design, testing different tools or equipment, trialling production processes, measuring or working out dimensions, testing of prototypes and further refinement.

Production

Safe production of the final design or multiple copies of the final design.

Fine tuning the production process, such as division of labour for batch or mass production.

Use of intended materials and appropriate tools to safely make the solution to the design problem.

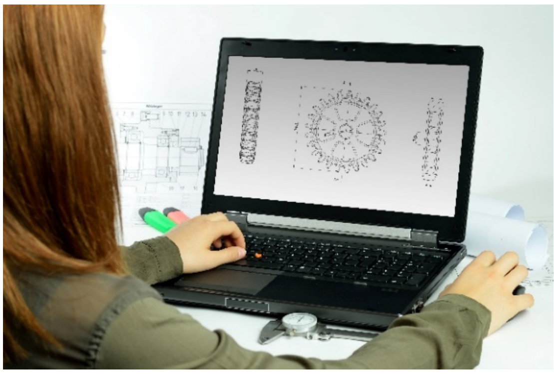
Evaluation

Reflection on the process taken and the success of the design.

Evaluation can lead to further development or improvement of the design and can be a final stage of the design process before a conclusion is reached.

Could be formal or informal and verbal or written.

Appendix 4B: Drawing in the design process


istockphoto.com

Incorporating the design process into the STEM modules will often result in the need for students to draw plans of their designs. This can be done at a simple level using hand drawn sketches or at a more technical level using computer-aided design (CAD).

By developing skills using industry-standard software, students may be well-placed to explore future career pathways.

There are several CAD software options; two free examples are detailed below. *Autodesk* is a third package that is also free for educational use.

Tinkercad

- Format: Web-based app requiring internet access via a browser
- Purpose: A simple, online 3D design and 3D printing app
- Home: *www.tinkercad.com*
- Blog: *blog.tinkercad.com*
- Tutorials: *www.tinkercad.com/learn*
- Feature: Connects to 3D printing and laser cutting.

SketchUp

- Format: Can be downloaded and installed on devices, or used in a browser
- Purpose: Enables students to draw in 3D
- Home: *www.sketchup.com* 'Products' '*SketchUp for Schools*'
- Help centre: *help.sketchup.com/en*
- Blog: *blog.sketchup.com*
- Tutorials: *www.youtube.com/user/SketchUpVideo*. From beginner tool tips to intermediate and advanced modelling techniques, the video tutorials help to build *SketchUp* skills.

Appendix 5: Student journal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When students reflect on learning and analyse their ideas and feelings, they self-evaluate, thereby improving their metacognitive skills.

This module encourages students to self-reflect and record the stages of their learning in a journal, which may take the form of a written journal, a portfolio or a digital portfolio.

Using digital portfolios can help develop students' information and communication technology (ICT) capability.

Reflective practice and recording can be supported in classrooms by creating opportunities for students to think about and record their learning through notes, drawings or pictures. Teachers should encourage students to revisit earlier journal entries to help them observe the progress of their thoughts and understanding.

Journals are a useful tool that gives teachers additional insight into how students value their own learning and progress, as well as demonstrating their individual achievements.

The following links provide background information and useful apps for journaling.

Reflective journal (University of Technology Sydney) www.uts.edu.au/sites/default/files/reflective_journal.pdf
Reflective writing (University of New South Wales Sydney)) student.unsw.edu.au/reflective-writing
Balancing the two faces of ePortfolios (Helen Barrett, 2009) electronicportfolios.org/balance/Balancing.jpg
Digital portfolios for students (Cool tools for school) cooltoolsforschool.wordpress.com/digital-student-portfolios
Kidblog – digital portfolios and blogging kidblog.org/home
Evernote (a digital portfolio app) evernote.com
Weebly for education (a drag and drop website builder) education.weebly.com
Connect – the Department of Education's integrated, online environment connect.det.wa.edu.au

Appendix 6: Student activity sheet 1.0: Journal checklist


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As an ongoing part of this module, you have been keeping a journal of your work.

Before submitting your journal to your teacher, please ensure you have included the following information.

- Tick each box once complete and included.
- Write N/A for items that were not required in this module.

Your name and group member's names or photographs	
An explanation of the problem you are solving	
Your notes from *Activity 1*	
Your notes from *Activity 2*	
Your notes from *Activity 3*	
Your notes from *Activity 4*	
Student activity sheet 1.4: Two-point threshold test	
Student activity sheet 1.5: Hot and cold two-point threshold test	
Student activity sheet 1.6: Frequency hearing test	
Student activity sheet 1.7: Visualising sounds	
Student activity sheet 1.8: Reaction time test	
Student activity sheet 3.1: Design brief	
Student activity sheet 4.1: Presentation review	
Student activity sheet 4.2: Ladder of feedback	
Student activity sheet 4.4: Self-evaluation	

Student activity sheet 1.0: Journal checklist	

Appendix 7: Teacher resource sheet 1.1: Cooperative learning – Roles

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Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

When students are working in groups, positive interdependence can be fostered by assigning roles to group members.

These roles could include:

- Working roles such as Reader, Writer, Summariser, Timekeeper
- Social roles such as Encourager, Observer, Noise monitor, Energiser.

Further to this, specific roles can be delineated for specific activities that the group is completing. It can help students if some background to the purpose of group roles is made clear to them before they start, but at no time should the roles get in the way of the learning. Teachers should decide when or where roles are appropriate to given tasks.

istockphoto.com

Appendix 8: Teacher resource sheet 1.2: Cooperative learning – Jigsaw

Cooperative learning frameworks create opportunities for groups of students to work together, generally for a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

The jigsaw strategy typically has each member of the group becoming an 'expert' on one or two aspects of a topic or question being investigated. Students start in their cooperative groups, then break away to form 'expert' groups to investigate and learn about a specific aspect of a topic. After developing a sound level of understanding, students return to their cooperative groups and teach each other what they have learnt.

Within each expert group, issues such as how to teach the information to their group members are considered.

Step 1	**Cooperative groups** (of four students)	**1 2 3 4**		**1 2 3 4**	
Step 2	**Expert groups** (size equal to the number of groups)	**1 1**	**2 2**	**3 3**	**4 4**
Step 3	**Cooperative groups** (of four students)	**1 2 3 4**		**1 2 3 4**	

Appendix 9: Teacher resource sheet 1.3: Cooperative learning – Think-pair-share

istockphoto.com

Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

In the 'think' stage, each student thinks silently about a question asked by the teacher.

In the 'pair' stage, students discuss their thoughts and answers to the question in pairs.

In the 'share' stage, students share their answer, their partner's answer or what they decided together. This sharing may be with other pairs or with the whole class. It is important also to let students 'pass'. This is a key element of making the strategy safe for students.

The think-pair-share strategy increases student participation and provides an environment for higher levels of thinking and questioning.

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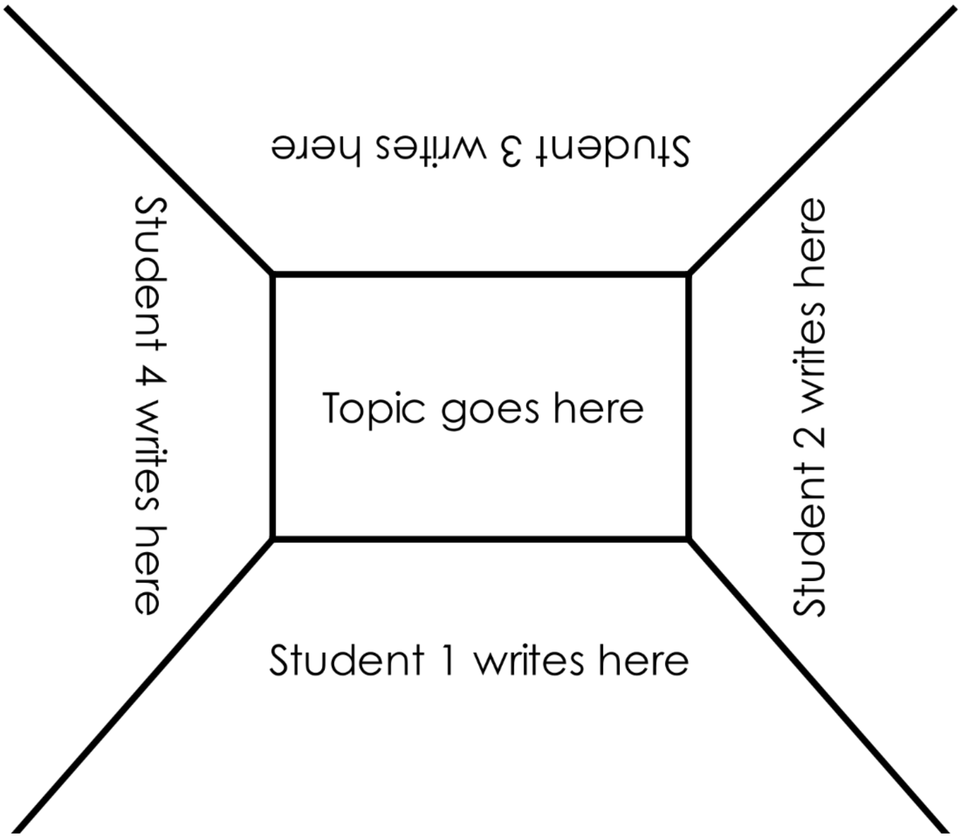
Appendix 10: Teacher resource sheet 1.4: Cooperative learning – Placemat

Cooperative learning frameworks create opportunities for groups of students to work together, generally for a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can help students develop personal and social capability.

istockphoto.com

The placemat strategy involves students working collaboratively to record prior knowledge about a common topic and brainstorm ideas. It also allows teachers to readily see the contribution of each student. The diagram below shows a typical placemat template.



STEM Consortium

Appendix 11: Student activity sheet 1.5: Two-point threshold test

Introduction

Humans greatly depend on the sense of vision to detect and distinguish objects. Despite this, the sense of touch can provide information about an object that is not easily detectable by vision; such as surface texture. The brain receives information from certain receptors within the skin when an object is touched. Higher concentrations of these receptors within a certain area of the skin are projected onto a larger part of the brain that receives touch sensations than for areas of the skin with lower concentrations of these receptors. This results in different parts of the body being more sensitive to touch than others.

Task

In this activity, you will investigate the problem: *How far apart on the skin must two pointed objects be so that a person can tell that there are two objects rather than one?* This will involve the measurement and recording of two-point discrimination distance data for different areas of the skin. The results are then compared with other groups. This task is based on the *How sensitive is my skin?* experiment in the *Our sense of touch student guide (E. H. Chudler, n.d.)* *faculty.washington.edu/chudler/pdf/mmsg.pdf*.

Apparatus

- Toothpicks
- Rulers
- Corks or plasticine (to make the probes)
- Blindfolds (optional)
- Graph paper

Summary of steps

- Use toothpick probes to collect two-point discrimination data
- Calculate the mean threshold values for the minimum distance for two-point discrimination for different skin areas being tested
- Graph the mean threshold values for the different skin areas.

Instructions

Safety precautions

1. Ensure that all standard laboratory safety guidelines are followed, and precautions are taken to avoid the spread of germs. This will include washing hands after collecting the data.
2. For each student subject being tested, fresh toothpicks must be used.
3. When applying the toothpick points, this must be done gently.
4. The student subject will need to close their eyes or use a blindfold. If blindfolds are used, these should not be shared.

Collection of data

5. One student will be the subject and the other student the tester. The subject must either close their eyes or wear a blindfold so they do not watch the procedure. The tester will use the toothpick to probe and collect data.
6. The tester will use a cork or small amount of plasticine with two toothpicks stuck in it. The distance between the toothpick ends is then able to be varied.
7. The tester will begin the experiment with the first skin area from the data recording table and start with toothpicks set to be about 50 mm apart.
8. Making sure that two points touch the skin at the same time, the subject is asked how many points they feel.
9. If the subject feels two points, the toothpick points should be moved closer together. If the subject feels one point, then the toothpick points are too close and should be separated further until two points are felt.
10. Repeat Steps 8 and 9 until the subject reports "one point" for the first time.
11. The toothpick points should then be moved apart by 1 or 2 mm at a time to allow an accurate measurement of the minimum distance for two-point discrimination to be made. Record this minimum distance value.
12. Repeat Steps 8–11 until three measurements for the body area being tested have been recorded.
13. Repeat the process in Steps 8–12 until data for all skin areas in the recording table have been measured and recorded.
14. If another person becomes the subject, fresh toothpicks need to be used.

Analysing data

15. Calculate the mean threshold value for the three test results of the minimum distance for two-point discrimination for each skin area.
16. Round the mean threshold values for each of the tested skin areas to the closest values of 3.75 mm, 7.5 mm, 15 mm, 30 mm, and 60 mm. This information will be used in the next activity.
17. Create a graph of your mean threshold values for the minimum distance for two-point discrimination and the skin areas tested. Create this graph large enough so that other threshold values can be added at a later stage.

Observations and analysis

Identify at least three interesting observations you made while conducting this experiment.

Consider how you could improve this experiment.

Data recording table

	Minimum distance for two-point discrimination				
Skin area for testing	**Test 1 (mm)**	**Test 2 (mm)**	**Test 3 (mm)**	**Mean threshold value (mm)**	**Rounded threshold value (mm)**
Forehead					
Cheek					
Forearm					
Palm of hand					
Tip of thumb					
Tip of index finger					
Back of lower leg					
Back					
Top of foot					

Appendix 12: Student activity sheet 1.6: Hot and cold two-point threshold test

Introduction

As was explored when completing *Student activity sheet 1.5: Two-point threshold test*, the sense of touch provides information to the brain from certain receptors within the skin. The concentration of these receptors within a specific area of the skin results in different parts of the body being more sensitive than others. Through the use of the two-point threshold test, an understanding of the sensitivity of the skin can be determined by seeing how far apart on the skin two pointed objects needed to be so that a person could tell that there were two objects rather than one. Additional receptors within the skin are sensitive to temperature and pain.

Task

In this activity, you will investigate the problem: *What is the effect of skin temperature when determining how far apart two pointed objects must be so that a person can tell that there are two objects rather than one?* This will involve heating or cooling of the skin surface before the measurement and recording of two-point discrimination distance data for different areas of the skin. Results are compared with the other groups and with the data recorded when heating or cooling the skin. This task is based on the *How sensitive is my skin?* experiment in the *Our sense of touch student guide (E. H. Chudler, n.d.)* faculty.washington.edu/chudler/pdf/mmsg.pdf.

Apparatus

- Toothpicks
- Rulers
- Corks or plasticine (to make the probes)
- Heat packs and ice cubes
- Blindfolds (optional)
- Graph paper

Summary of steps

- Use toothpick probes to collect two-point discrimination data
- Calculate the mean threshold values for the minimum distance for two-point discrimination for different skin areas being tested after heating and cooling
- Graph the mean threshold values for the different skin areas being tested after heating and cooling.

Instructions

Safety precautions

1. Ensure that all standard laboratory safety guidelines are followed, and precautions are taken to avoid the spread of germs. This will include washing hands after collecting the data.
2. For each student subject being tested, fresh toothpicks must be used.
3. When using a heat pack over an area, ensure that it is only heated to the point that does not cause a burn. When applying ice over an area, ensure that it is not held there for too long and causes discomfort.
4. When applying the toothpick points, this must be done gently.
5. The student subject will need to close their eyes or use a blindfold. If blindfolds are used, these should not be shared.

Collection of data

6. One student will be the subject and the other student the tester. The subject must either close their eyes or wear a blindfold, as they must not watch the procedure. The tester will use the toothpick to probe and collect data.
7. The tester will use a cork or small amount of plasticine with two toothpicks stuck in it. The distance between the toothpick ends is then able to be varied.
8. This experiment will be conducted by heating or cooling the surface of the skin before conducting the test. The process will be discussed as a class before commencing to ensure consistency in taking the measurements.

When heating: The tester will begin by placing a heat pack on the area to be tested for 15 seconds before testing.

When cooling: The tester will begin by rubbing an ice cube over the area for 10–12 seconds before testing.

9. The tester will begin the experiment with the first skin area from the data recording table and start with toothpicks set to be about 50 mm apart.
10. Making sure that two points touch the skin at the same time, the subject is asked how many points they feel.
11. If the subject feels two points, the toothpick points should be moved closer together. If the subject feels one point, then the toothpick points are too close and should be separated further until two points are felt.
12. Repeat Steps 10 and 11 until the subject reports "one point" for the first time.
13. The toothpick points should then be moved apart by 1 or 2 mm at a time to allow an accurate measurement of the minimum distance for two-point discrimination to be made. Record this minimum distance value.
14. Repeat Steps 10–13 until three measurements for the body area being tested have been recorded (either for heating or cooling of the skin).
15. Repeat the process in Steps 10–14 until data for all skin areas in the data recording table have been measured and recorded, and for both heating and cooling of the skin before testing.
16. If another person becomes the subject, fresh toothpicks need to be used.

Analysing data

17. Calculate the mean threshold value for the three test results of the minimum distance for two-point discrimination for each skin area, for both heating and cooling of the skin before testing.
18. Create a graph of your mean threshold values for the minimum distance for two-point discrimination and the skin areas tested, or add the heating and cooling of the skin data to the graph from the *Student activity sheet 1.5: Two-point threshold test*.

Observations and analysis

Identify at least three interesting observations you made while conducting this experiment. Compare the results you obtained when heating and cooling the skin to those obtained before testing.

Consider how you could improve this experiment.

Data recording table

Heating of skin surface before testing:

Heating of the skin using heat pack	Minimum distance for two-point discrimination			
Skin area for testing	**Test 1 (mm)**	**Test 2 (mm)**	**Test 3 (mm)**	**Mean threshold value (mm)**
Forehead				
Cheek				
Forearm				
Palm of hand				
Tip of thumb				
Tip of index finger				
Back of lower leg				
Back				
Top of foot				

Cooling of skin surface before testing:

Cooling of the skin using ice cube	Minimum distance for two-point discrimination			
Skin area for testing	**Test 1 (mm)**	**Test 2 (mm)**	**Test 3 (mm)**	**Mean threshold value (mm)**
Forehead				
Cheek				
Forearm				
Palm of hand				
Tip of thumb				
Tip of index finger				
Back of lower leg				
Back				
Top of foot				

Appendix 13: Student activity sheet 1.7: Frequency hearing test

Introduction

Humans can hear sound over a range of frequencies. This range is referred to as the hearing range and varies between individuals and with age.

Task

In this activity, you will investigate your hearing range by determining the upper and lower frequencies that your ears are sensitive to by using an *Online tone generator* (T. P. Szynalski, 2012) *www.szynalski.com/tone-generator/*. By changing the frequency of the sound, you can determine the frequency value at which you are no longer able to hear the sound. This will allow the class audible frequency range to be determined.

Apparatus

- Headphones or earphones
- Device connected to the internet

Summary of steps

- Determine the upper and lower frequencies that you can hear
- Compare the range of audible frequencies within the class.

Instructions

You will need to use headphones or earphones in a quiet room for best results.

1. Set the volume on your computer or device to 50% and plug in your headphones or earphones.
2. Go to *www.szynalski.com/tone-generator/*.
3. Set the volume on the *Online Tone Generator* to be 100%.
4. Press PLAY.
5. Move the slider to the right to increase the frequency of the tone and record the highest frequency you can hear.
6. Move the slider to the left to decrease the frequency of the tone and record the lowest frequency you can hear.
7. Press STOP, then wait 30 seconds.
8. Repeat Steps 4 to 7 another two times and record your results.
9. Calculate the mean frequency values for the highest and lowest frequencies you were able to hear.

Results

The type of device used to generate tones: ____

The type of headphones/earphones used: ____
(eg wired, wireless, noise-cancelling etc)

Observations

Identify at least two interesting observations you made while conducting this experiment.

____
____
____
____
____
____
____
____
____
____
____

Data recording table

	Test 1	**Test 2**	**Test 3**	**Mean value (Hz)**
Highest frequency (Hz)				
Lowest frequency (Hz)				

Using the mean values from above, determine your audible frequency range in both scientific notation and in kHz.

Audible frequency range: (scientific notation)	
Audible frequency range: (kHz)	

Appendix 14: Student activity sheet 1.8: Visualising sounds

Introduction

A microphone can be used to capture the vibrations of sound waves and convert these to an electrical signal. This electrical signal can be viewed on an oscilloscope to allow the period of the sound wave to be determined. Once the period is known, the frequency of the sound can be calculated by using the formula:

$$f = \frac{1}{T}$$

where, f= frequency of the wave (Hz)

T= period of the wave (seconds)

Task

In this activity, you will use an online oscilloscope to visualise different sounds and then determine the period of these sounds. The frequency of these sound can then be calculated.

Apparatus

- Separate microphone, or computer-microphone
- Device connected to the internet

Summary of steps

- Visualisation of a given sound on an oscilloscope
- Determination of the period of the sound wave
- Calculation of the frequency of the sound.

Instructions

You will need to use an external microphone in a quiet room for best results.

1. Access the Virtual oscilloscope (Academo.org, 2020) academo.org/demos/virtual-oscilloscope/

Confirming how to use the oscilloscope

2. Under Input select 'Sine Wave (amplitude 5V)' and change the Input Wave Frequency to be 800 Hz.
3. Change the Seconds / div to be 500 μs.
4. By looking at one complete wavelength, confirm that this takes up 2.5 divisions on the screen.
5. 2.5 divisions × 500 μs $= 2.5 \times 500 \times 10^{-6}$

   $= 1.25 \times 10^{-3}$ s (Period: T)
6. Using $f = \frac{1}{T}$ the frequency can be calculated as:

$$f = \frac{1}{1.25 \times 10^{-3}}$$

$$= 800 \text{ Hz}$$

Visualising different sounds and calculation of frequency

7. Under Input select 'Live Input (5 V peak amplitude)' and say "ah" smoothly into the microphone.
8. Check the Freeze Live Input box to stop recording.
9. Adjust the Seconds / div so that around 2–4 full (repeating) wavelengths of the sound can be seen on the display. Record this value in the data recording table. Convert from ms or μs to seconds.
10. Adjust the Volts / div if necessary, so that the waveform is large enough.
11. Adjust the Horizontal Offset to align a peak or trough with a Division line.
12. Measure the number of divisions on the screen for one complete wavelength.
13. Multiply the Seconds / div value by the number of divisions to determine the period of the wave (in seconds).
14. Calculate the frequency of the sound from the period (in Hz).
15. Repeat Steps 7–14 for other sounds such as eh, ee, oh, oo, tsk, shh, ka. You can also try doh, ray, me, far, so, la, ti, doh, as well as other consonants and sounds.

Data recording table

Sound	**Seconds / div (ms, μs)**	**Seconds / div (secs)**	**Divisions for one complete wavelength**	**Seconds / div × Divisions (Period: T secs)**	$f = \frac{1}{T}$ **(Hz)**	**Frequency (Hz) in scientific notation**
ah						
eh						
ee						
oh						
oo						
tsk						
shh						
ka						

Appendix 15: Student activity sheet 1.9: Reaction time test

Introduction

Reaction time is the period between the appearance of a stimulus and the start of the muscular response to this stimulus. The known properties of gravity can be used to determine how long a person takes to respond to the dropping of an object by measuring the distance the object falls before being caught.

The mean catch distance can be converted into a mean reaction time by using knowledge of gravity and motion. Here:

$$S = ut + \frac{1}{2}a\,t^2$$

Where: S = displacement in metres

u = initial velocity (ms^{-1}) = 0 ms^{-1}

a = acceleration due to gravity (ms^{-2}) = 9.8ms^{-2}

t = time in seconds (s)

This can be rearranged to allow the reaction time to be calculated:

$$t = \sqrt{\frac{2S}{a}}$$

If the distance the ruler falls is 15 cm, then S = 0.15 m and the time taken to catch the ruler will be calculated using: $t = \sqrt{\frac{2\times0.15}{9.8}}$, giving $t = 0.175s$ (175 ms).

Task

In this activity, you will calculate your reaction time by measuring the distance a ruler falls before you catch it.

Apparatus

- Metre ruler

Summary of steps

- Measure how far a ruler drops before it is caught
- Calculate the reaction time.

Instructions

Students work in pairs, with one student the subject and the other the assistant.

1. The assistant holds the ruler and lets it hang vertically. The subject places their outstretched index finger and thumb either side of the ruler with the top of their thumb level with the 0 cm mark on the ruler so that they are ready to catch it when it falls. Their fingers should not be touching the ruler.
2. The subject has their eyes open and without warning the assistant releases the ruler. The subject catches the ruler between their index finger and thumb as quickly as possible.

3. Record the distance between the 0 cm mark and the top of the subject's thumb where the ruler has been caught.
4. Repeat the process five times so that a mean catch distance can be calculated.

Students should repeat this process. The following Step 2 release variations are used:

A. The subject has their eyes open and without warning the assistant releases the ruler.
B. The subject has their eyes open. With a verbal warning from the assistant when the ruler will be dropped (such as a countdown, or a single warning word), the assistant releases the ruler.
C. The subject has their eyes open. With a touch on the shoulder from the assistant to indicate when the ruler will be dropped, the assistant releases the ruler.
D. The subject has their eyes closed. With a verbal cue from the assistant to indicate when the ruler will be dropped, the assistant releases the ruler.
E. The subject has their eyes closed. With a touch on the shoulder from the assistant to indicate when the ruler will be dropped, the assistant releases the ruler.
F. The subject is distracted, such as reading a sentence out loud, and without warning the assistant releases the ruler.

Observations and analysis

Identify at least two interesting observations you made while conducting this experiment.

Consider how you could improve this experiment.

Data recording table

Release Type (A-F)	Trial 1 (cm)	Trial 2 (cm)	Trial 3 (cm)	Trial 4 (cm)	Trial 5 (cm)	Mean catch distance (cm)
A						
B						
C						
D						
E						
F						

Calculations

1. Calculate the reaction time using the formula: $t = \sqrt{\frac{2S}{a}}$
2. Write the reaction time in scientific notation.
3. Convert the reaction time to milliseconds.

Here, S = mean catch distance (m).

Release Type (A-F)	S (m)	$t = \sqrt{\frac{2S}{9.8}}$ (secs)	Reaction time: scientific notation (s)	Reaction time: milliseconds (ms)
A				
B				
C				
D				
E				
F				

Compare your results to *The fighter pilot challenge* ratings (The Open University, n.d.) www.open.edu/openlearn/sites/www.open.edu.openlearn/files/open2files/g-force.pdf. Are your results consistent with the reaction times shown in the table?

____

____

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Appendix 16: Student activity sheet 3.1: Design brief

Group members ____

Problem	
Our focus area	
Issues addressed	
Supporting facts and data	
Audience	
Key messages	
Mode of delivery	

Appendix 17: Student activity sheet 4.1: Presentation review

Things I would keep the same

____

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____

____

Things I would change

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____

____

Extra things I could do

____

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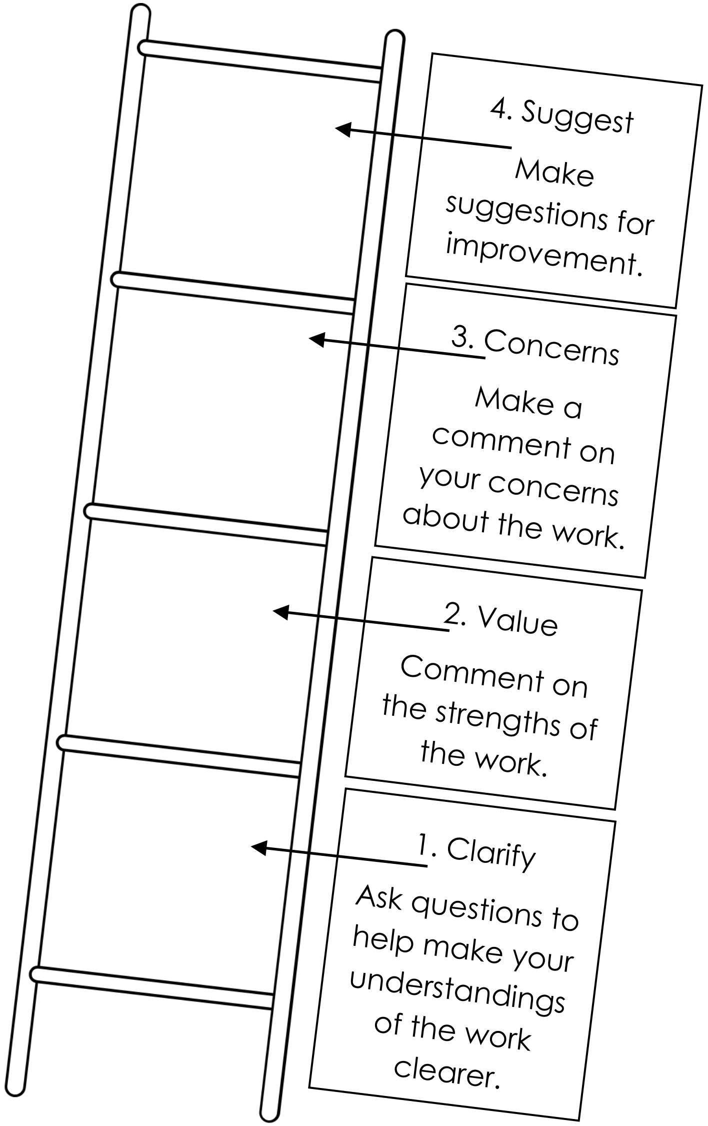
____

____

Photographs or drawing

Appendix 18: Student activity sheet 4.2: Ladder of feedback



Suggest	
Concerns	
Value	
Clarify	

Appendix 19: Teacher resource sheet 4.3: Evaluation

Key: 1. Sometimes 2. Consistently 3. Independently and consistently	Student name												
Remains focused on tasks presented													
Completes set tasks to best of their ability													
Works independently without disrupting others													
Manages time effectively													
Cooperates effectively within the group													
Contributes to group discussions													
Shows respect and consideration for others													
Uses appropriate conflict resolution skills													
Actively seeks and uses feedback													

Appendix 20: Student activity sheet 4.4: Self-evaluation

***Assist me* reflection**

Photograph or drawing

What learning experience did you create?	How do you feel about your creation?
 White hat	 Red hat
What do you like about your creation?	What could you have done better?
 Yellow hat	 Silver hat

What would you do differently?
 Green hat

Notes