# iSTEM – MedTech



Contents

[MedTech 2](#_Toc126768524)

[Duration of learning 2](#_Toc126768525)

[Inquiry question 2](#_Toc126768526)

[Outcomes 2](#_Toc126768527)

[Rationale 4](#_Toc126768528)

[Aim 5](#_Toc126768529)

[Purpose and audience 5](#_Toc126768530)

[When and how to use this document 5](#_Toc126768531)

[Learning sequences 6](#_Toc126768532)

[Weeks 1 and 2 7](#_Toc126768533)

[Weeks 3 and 4 17](#_Toc126768534)

[Weeks 5 and 6 24](#_Toc126768535)

[Weeks 7 and 8 34](#_Toc126768536)

[Weeks 9 and 10 39](#_Toc126768537)

[Reflection and evaluation 47](#_Toc126768538)

[Additional information 48](#_Toc126768539)

[Assessment for learning 48](#_Toc126768540)

[Differentiation 49](#_Toc126768541)

[About this resource 50](#_Toc126768542)

[References 54](#_Toc126768543)

[Further reading 57](#_Toc126768544)

## MedTech

MedTech includes products, services, or solutions that use medical technology to improve people’s health by preventing, diagnosing, monitoring, and treating disease. Medical technologies have the potential to positively transform lives and improve quality of life.

MedTech is a rapidly emerging industry driving high demand for professionals. Advancements in this industry often evolve in parallel with developments in other associated industries including advanced manufacturing, robotics, and cyber security. Modern medical technologies increasingly allow patients to play a greater role in their own care and smart devices increase connection of patients with health-care providers.

### Duration of learning

Indicative time – 25 hours.

### Inquiry question

Can innovation improve access to medical technologies?

### Outcomes

A student:

* **ST5-1** designs and develops creative, innovative, and enterprising solutions to a wide range of STEM-based problems
* **ST5-2** demonstrates critical thinking, creativity, problem solving, entrepreneurship and engineering design skills and decision-making techniques in a range of STEM contexts
* **ST5-3** applies engineering design processes to address real-world STEM-based problems
* **ST5-4** works independently and collaboratively to produce practical solutions to real-world scenarios
* **ST5-5** analyses a range of contexts and applies STEM principles and processes
* **ST5-6** selects and safely uses a range of technologies in the development, evaluation, and presentation of solutions to STEM-based problems
* **ST5-7** selects and applies project management strategies when developing and evaluating STEM-based design solutions
* **ST5-8** uses a range of techniques and technologies, to communicate design solutions and technical information for a range of audiences
* **ST5-9** collects, organises, and interprets data sets, using appropriate mathematical and statistical methods to inform and evaluate design decisions
* **ST5-10** analyses and evaluates the impact of STEM on society and describes the scope and pathways into employment.

Outcomes referred to in this document are from the [iSTEM course document](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset2) © NSW Department of Education for and on behalf of the Crown in the State of New South Wales (2021).

### Rationale

Australian businesses competing in a global economy will need more employees trained in science, technology, engineering, and mathematics (STEM). Research indicates that 75% of the fastest-growing occupations require STEM skills. Global accounting firm PwC (formerly known as PricewaterhouseCoopers) produced a report titled [‘A smart move’](https://www.pwc.com.au/publications/a-smart-move.html) where it found that shifting just 1% of the Australian workforce into STEM roles would add $57.4 billion to the gross domestic product (GDP) (net present value over 20 years).

iSTEM is a student-centred Stage 5 elective course that delivers science, technology, engineering, and mathematics education in an interdisciplinary, innovative, and integrated fashion. It was developed in direct response to industry’s urgent demand for young people skilled in science, technology, engineering, and mathematics.

The course was developed in collaboration with, and is supported by, industry, business, government, and universities, ensuring that students develop future-focused STEM skills. The course has a number of specialised topics, many of which are aligned with NSW State Government priority industries, identified in the [NSW Industry Development Framework](https://www.investment.nsw.gov.au/living-working-and-business/nsw-industry-development-framework/).

iSTEM develops enabling skills and knowledge that increasingly underpin many professions and trades, and the skills of a technologically enabled workforce. It provides students with learning opportunities to develop knowledge and skills to use the most up-to-date technologies including additive manufacturing (3D printing), laser cutters, augmented and virtual reality, drones, smart robotics and automation systems, artificial intelligence (AI) and a range of digital systems.

Students gain and apply knowledge, deepen their understanding, and develop collaborative, creative and critical thinking skills within authentic, real-world contexts. The course uses inquiry, problem and project-based learning approaches to solve problems and produce practical solutions utilising engineering design processes.

iSTEM is aligned to the concept of ‘[Industry 4.0](https://www.weforum.org/agenda/2019/01/why-companies-should-strive-for-industry-4-0/)’ which refers to a new and emerging phase in the industrial revolution that heavily focuses on interconnectivity, automation, machine learning and real-time data.

iSTEM has been developed to meet the goals of National Federation Reform Council (NFRC) Education Council’s [National STEM School Education Strategy (2016-2026)](https://www.dese.gov.au/education-ministers-meeting/resources/national-stem-school-education-strategy), and supports the NSW Government’s [NSW Industry Development Framework](https://www.investment.nsw.gov.au/living-working-and-business/nsw-industry-development-framework/), the NSW Department of Education’s [Rural and Remote Education Strategy (2021-2024)](https://education.nsw.gov.au/about-us/strategies-and-reports/rural-and-remote-education-strategy-2021-24) and the [High Potential and Gifted Education policy](https://education.nsw.gov.au/policy-library/policies/pd-2004-0051).

### Aim

The aim of the course is to engage and encourage student interest and skills in STEM, appreciate the scope, impact and pathways into STEM careers and learn how to work collaboratively, entrepreneurially, and innovatively to solve real-world problems.

### Purpose and audience

This teaching resource is for teachers delivering or planning to deliver the course. The learning sequence demonstrates how a combination of outcomes can be used to develop teaching and learning activities. It also suggests a range of resources to support teachers when planning and/or teaching the course.

### When and how to use this document

Use this resource when designing learning activities that align with the course outcomes and content. The activities and resources can be used directly or may be adapted based on teacher judgment and knowledge of their students. Consult the course document for further details on timing of core, elective and specialised topics.

## Learning sequences

This sample learning sequence has been prepared by the NSW Department of Education. It has been developed as a guide for teachers to assist in the development of a teaching and learning program contextualised to an individual school's needs. The scope and depth of the content covered should relate to the school's context, expertise of the teachers delivering the course and the prior knowledge of the students. Plan learning activities that are inclusive and accommodate the needs of all students, in your classroom from the beginning. Some students may require more specific adjustments to allow them to participate on the same basis. Space is provided to record adjustments and enhancements that are made to the learning sequence during its implementation, in order to meet the individual needs of students and to allow for differentiation of the iSTEM curriculum. For further advice see [Additional information](#_Additional_information) later in this document.

### Weeks 1 and 2

**Teacher note:** Medical technologies detect, diagnose, treat, and/or prevent disease and disabilities. Assess this learning sequence within the context of your school and class and adjust where appropriate.

Table 1 – MedTech weeks 1 and 2 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 1 – Introduction****ST5-5**Students:* explore traditional medicinal methods used by Aboriginal and Torres Strait Islander peoples and explore how these practices can work alongside western medical frameworks.
 | **Teacher**Introduce medical technology. Lead class discussion regarding their conceptions of medical technology.Identify and describe types of medical technologies. Briefly explore the historical development of a medical technology, based on class interest.**Teacher and students**Explore [10 bush medicines that have been curing people for generations](https://www.sbs.com.au/nitv/article/10-bush-medicines-that-have-been-curing-people-for-generations/128n762uh). Identify and describe the use of traditional medicines to treat disease.**Extension**Explore intellectual property cases to protect Indigenous knowledges from [biopiracy](https://theconversation.com/biopiracy-when-indigenous-knowledge-is-patented-for-profit-55589), for example, [Protecting Indigenous bush foods and medicines against biopiracy](https://newsroom.unsw.edu.au/news/social-affairs/protecting-indigenous-bush-foods-and-medicines-against-biopiracy).Explore research into [tea tree oil](http://europepmc.org/article/med/11338678). Read the abstract to identify the research approach used and the conclusions made. | Students can identify and describe traditional food and medicinal treatments. | Provide key terms to assist with vocabulary building and knowledge acquisition.Skim and scan webpage to help orientate students. Demonstrate active reading, such as pre-read, read and re-reading for processing, of information to extract relevant information.Students research local bush medicines in their local area and the traditional Aboriginal language names for them.Students can use their preferred communication style to demonstrate evidence of learning. |
| **Prosthetics****ST5-10**Students:* identify the needs of individuals and society and how this drives MedTech innovation
* evaluate short and long-term consequences of MedTech solutions on individuals, and society.
 | **Teacher**Introduce prosthetic devices as medical technologies used to replace, repair or augment a missing or impaired part of the body.**Teacher and students**Identify and discuss reasons a prosthesis may be required, for example:* amputation
* damage
* congenital disease.

**Teacher**Present [New bionics let us run, climb and dance | Hugh Herr (19:00)](https://www.youtube.com/watch?v=CDsNZJTWw0w).**Teacher and student**Identify the needs presented in this video that drives medical innovation and evaluate the consequences of this medical technology. | Students can describe a prosthetic device.Students are able to describe situations that may require a prothesis. | Develop a socially supportive classroom environment and demonstrate respect when exploring disease and disability.Use closed captions when viewing video to assist understanding and vocabulary building.Pause video after certain sections to discuss technical language, for example:* mechanical interface
* dynamic interface
* electronic control.
 |
| **Developing prosthetics****ST5-3**Students:* describe technologies related to MedTech innovations
* investigate technologies to model and/or prototype MedTech solutions.
 | **Teacher**Introduce the concept of designing a prosthetic hand. Present [How 3-D-Printed Prosthetic Hands Are Changing These Kids’ Lives | Short Film Showcase (3:29)](https://www.youtube.com/watch?v=Cl8ijPGEKO8).Present [Every Prototype that Led to a Realistic Prosthetic Arm | WIRED (5:46)](https://www.youtube.com/watch?v=UOJ0lkr2SFc).**Teacher and student**Assess the second video and compare portions of the video to the [iSTEM Engineering Design Process [PDF 2.91MB]](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-engineering-design-process.pdf). | Students can identify segments of the video that align with the engineering design process, for example:* define
* identify
* brainstorm
* design
* prototype
* evaluate
* iterate
* communicate.
 | Use closed captions when viewing video to assist understanding and vocabulary building.Replay and pause video after certain sections to discuss technical language, for example:* increasing grip
* prototypes
* tendon systems vs linkages.
 |
| **Weekly reflection** | **Students**Complete weekly reflection using the following steps:* identify tasks undertaken, new knowledge, understanding or skills.
 | Students answer reflective questions, for example:* What did I learn about this week?
* Did I learn best when receiving information, applying knowledge, or communicating?
 | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.Procedural recount to be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 2 – Hand anatomy****ST5-3**Students:* investigate human physiology and anatomy related to MedTech problem-solving tasks.
 | **Teacher**Present [Hand Anatomy (6:46)](https://www.ypo.education/orthopaedics/hand-wrist/hand-anatomy-t191/video/).**Teacher and student**Identify and describe the function of ligaments, tendons, and cartilage regarding the movement of the fingers.Explain how forearm muscles and tendons work together to flex the fingers.**Extension**Present [Hand Anatomy Animated Tutorial (11:03)](https://www.youtube.com/watch?v=zyl6eoU-3Rg) instead of the previous video for a more comprehensive description of hand anatomy. | Students can describe the mechanics of finger movement, especially the role of extrinsic muscles and long tendons. | Use closed captions when viewing video to assist understanding and vocabulary building.Replay and pause video after certain sections to discuss technical language, for example:* muscle and tendons
* ligaments
* flexion and extension.
 |
| **Dissection****ST5-3**Students:* investigate human physiology and anatomy related to MedTech problem-solving tasks.
 | **Teacher preparation****Read** [Performing a chicken wing dissection [PDF 800KB]](https://assist.asta.edu.au/sites/assist.asta.edu.au/files/SOP%20Performing%20a%20chicken%20wing%20dissection.pdf) **to prepare for the practical activity and create risk assessment.****Teacher note: Dissection scissors can be used instead of scalpels.****Teacher**Identify structural and functional similarities of tendons, ligaments, bones and muscles in humans and chickens. Present [Chicken Wing Dissection for Skeletal & Muscular Systems (6:00)](https://www.youtube.com/watch?v=T369i2kJNJE).Review risk assessment with students and explain the risks when conducting dissections.**Student**Safely conduct dissection.**Teacher**Actively question students during dissection, for example:* What happens when you squeeze this muscle?
* Is there an opposing muscle that has an opposite reaction?
* What happens to this movement if you cut this tendon?

**Teacher and student**Compare the movement of the wing to the movement of the hand.Reflect on the importance of tendons regarding the movement of the hand.**Extension (optional)**Compare the anatomies of the wing and hand with respect to the evolutionary concept of modified pentadactyl limbs. | Students can safely conduct a dissection.Students can communicate their understanding of the role of muscles and tendons in the flexion (bending of the finger) and extension (straightening of the finger) of joints.Students can explain and manage risks associated with a dissection. | Model the dissection and support students through the dissection process.Use a probe to point out structural features for students. Pre-prepare a dissected chicken wing so that muscle-tendon functions can be demonstrated.Use closed captions when viewing video to assist understanding and vocabulary building.Replay and pause video after certain sections to discuss technical language. |
| **Cardboard challenge****ST5-4**Students:* investigate human physiology and anatomy related to MedTech problem-solving tasks
* work individually and collaboratively to apply an engineering design process to complete problems and challenges.
 | **Teacher**Present [Engineering@Home – Challenge 5: The Prosthetic Hand Challenge (5:12)](https://www.youtube.com/watch?v=cbWCoEaQ_FY).Provide materials to students:* thick cardboard
* marker
* straws
* tape
* scissors
* string.

**Student**Complete prosthetic hand challenge.**Teacher and student**Use the engineering design process as a scaffold to suggest possible improvements to the model during the build.Identify structural and functional similarities of tendons, ligaments, bones and muscles in humans and the cardboard hand.**Compare this challenge to the prototyping of a prosthetic hand.** | Students can create a functional cardboard hand prototype.Students demonstrate capacity to adapt design to enhance functioning throughout build. | Present video to introduce scope of project and then replay video and pause at key points to assess student understanding.Use closed captions when viewing video to assist understanding and vocabulary building. |
| **Weekly reflection** | **Students**Complete weekly reflection evaluating new knowledge, understanding or skills in the light of previous knowledge. | Students answer reflective questions, for example:* What did I learn about this week?
 | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.Weekly reflection to be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 3 and 4

**Note:** The following weeks of this learning sequence focus on the creation of a 3D printed prosthetic hand. Teachers are encouraged to choose a design that suits your students, resources and context.

Table 2 – MedTech weeks 3 and 4 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 3 – Introduction to design****ST5-4, ST5-6**Students:* develop an understanding of the current and emerging challenges faced by the MedTech industry
* develop appropriate interdisciplinary language, conventions, and representations to communicate MedTech solutions
* investigate human physiology and anatomy related to MedTech problem-solving tasks.
 | **Teacher**Introduce the [3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/).**Teacher and student**Evaluate the design and discuss the functioning of different mechanisms.Compare mechanisms in this ‘robotic hand’ to biological anatomical structures, for example:* What parts are acting as tendons?
* Are ligaments present?
* Is a part acting as a tendon and a ligament?
* What anatomical parts are analogous to the motors?

Evaluate which features of the hand are variables and which are constants. Identify what would constitute a failure in a prosthetic hand design.**Teachers note**If 3D printers are unavailable use [Arduino - Make a Robotic Hand (Low Cost)](https://www.instructables.com/Arduino-Make-a-Robotic-Hand-Low-Cost/). | Students will be able to identify parts and features that are analogous to biological structures, for example:* nylon wire through ‘posterior’ holes are acting as tendons, ligaments and extensor mechanisms.
* nylon wire through ‘anterior’ holes are acting as tendons.
 | Skim and scan the webpage to help orientate students. Demonstrate active reading, such as pre-read, read and rereading for processing, of information to extract relevant information.Assist student in comparing the 3D design to biological anatomical structures. |
| **CAD****ST5-4, ST5-6**Students:* investigate technologies to model and/or prototype MedTech solutions.
 | **Teacher**Review the use of CAD from STEM fundamentals.Explore the [3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/) files.Review process of downloading appropriate 3D printing files and importing them into a CAD program.**Students**Download appropriate files and open in CAD.Evaluate 3D designs and identify potential complicating features.**Teacher**Use questioning to evaluate student understanding of 3D design. | Students can locate and manipulate appropriate files for CAD and CAM. | Use [Graduated Guidance [PDF 376KB]](https://education.nsw.gov.au/content/dam/main-education/campaigns/inclusive-education-hub/pdf/resources/Graduated_Guidance_Poster_FINAL_NSW_A4_-_TAGGED.pdf) to scaffold student independence when developing or practicing CAD skills.Include multiple opportunities for students to respond, for example:* verbally
* individually
* partner turn and talk
* non-verbally
* gesture
* response cards.
 |
| **CAM****ST5-6****Students:*** investigate technologies to model and/or prototype MedTech solutions.
 | **Teacher**Revise activity from last lesson.Outline potential issues with 3D printing, for example:* slicing settings
* brim
* supports
* adhesion.

**Teacher and students**Revise the use of slicing programs and prepare [3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/) files for printing, focussing on the fingers and hand files at this stage.**Student**Prepare files for 3D printing and begin print.**Teacher note:** A system for 3D printing larger parts ahead of time will be required due to printing time. | Students can locate and manipulate appropriate files for CAD and CAM.Students can prepare files for 3D printing. | Assist students in downloading and manipulating ‘stl.' files to prepare for printing. |
| **Weekly reflection** | **Students**Complete weekly reflection identifying tasks undertaken, new knowledge, understanding or skills. | Students answer reflective questions, for example:* Did I learn best when receiving information, applying knowledge, or communicating?
 | Procedural recount to be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 4 - Prototype build****ST5-6**Students:* employ commonly used tools, equipment, and techniques to develop MedTech solutions, models, prototypes, or experiments.
 | **Teacher**Review instructions in [3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/).**Direct students** to begin build by assembling a prototype consisting of the 4 **fingers and the hand.****Students****Use 3D prints and materials** to build an **initial** [3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/) **prototype.****Teacher note****Conduct risk assessment before using equipment.****Teacher****Assist students in fabrication of their design using available resources. Prompt students to try different techniques when they encounter build problems.****Discuss the iterative process and highlight further build time after prototyping.** | Students have constructed a physical prototype based on the instructions. | Actively assess student progress and assist where appropriate.Access [text version of the 3D Robotic Hand instructions [PDF 1443 KB]](https://content.instructables.com/pdfs/EOF/VXS8/J6WGY2E9/3D-Printed-Robotic-Hand.pdf) of instructions and adjust text to assist student understanding.Skim and scan webpage to help orientate students. Demonstrate active reading, such as pre-read, read and rereading for processing, of information to extract relevant information. |
| **Weekly reflection** | **Students**Complete weekly reflection evaluating new knowledge, understanding or skills in the light of previous knowledge. | Students answer reflective questions, for example:* What did I learn about this week?
* Did I learn best when receiving information, applying knowledge, or communicating?
 | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task. |

### Weeks 5 and 6

**Teachers note:** The week 5 learning sequence uses scientific methodology to test potential changes to the prosthetic design. You are encouraged to adjust the testing based on context and potential student questions.

Table 3 – MedTech weeks 5 and 6 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 5 – Using data****ST5-4**Students:* explore technologies used to collect and manage large quantities of data
* investigate how data is collected and managed by MedTech professionals to solve real-world challenges and improve decision making.
 | **Teacher****Describe the collection and analysis of data and the use of databases in MedTech.****Explain how databases enable thresholds and patterns to be** determined.**Present** [Life Without Limits | Prosthetics and Data (3:54)](https://www.youtube.com/watch?v=mqjBHmMGqmc)**.**Explain how **thresholds and** patterns in data can **be used to detect diseases or program responses in an effector such as an arm and hand.****Teacher and student****Identify how data could be collected and analysed to determine a response in these prostheses.****Extension (optional)****Explore the ethical use of data and potential bias and misuse, for example:*** **commercialisation of data**
* **cybersecurity**
* **historical bias from and misuse of data.**
 | Students demonstrate awareness of the technologies that can assist the collection, management, and analysis of large quantities of data. | Use closed captions when viewing videos to assist understanding and vocabulary building. |
| **Investigation****ST5-9**Students:* undertake firsthand investigations to collect valid and reliable data
* investigate how data is collected and managed by MedTech professionals to solve real-world challenges and improve decision making.
 | **Teacher preparation**Prepare an experiment using friction testing ideas, **for example:*** [Methods Used for Friction Testing](https://microtribodynamics.engr.tamu.edu/methods-used-for-friction-testing/)
* [Determining the Coefficient of Friction [PDF 87.4KB]](https://nfsi.org/wp-content/uploads/2013/10/Determining.pdf)

Print a **200 x 200 PLA sheet before class. Obtain other surfaces to test, for example:*** **flat rubber matting**
* **textured rubber matting**
* **sandpaper sheets**
* **foam matting.**

**Teacher**Introduce the concepts of friction and grip with students.**Pose question to students ‘what could I do to improve the grip of my prototype hand?’. Steer student responses to the surface of the hand and fingers.****Introduce an experiment to determine the change in friction if the surface of the hand is changed.****Introduce an experiment that tests the friction coefficient when pulling a mass along different surfaces.****Student**Conduct investigation to test the effect of different surfaces on friction.**Teacher and students**Evaluate the investigation and determine adjustments to the method. | Students can undertake a firsthand investigation to gather data on different materials. | Adjust experimental challenge by using an inquiry-based learning pedagogical (Banchi and Bell 2008) scaffold, for example:* structured inquiry – students gather data by using a method provided by the teacher to find an answer to a question
* guided inquiry – students develop a method to gather data to a question the teacher provides
* open inquiry - students develop a method to gather data to a question of their creation.
 |
| **Investigation****ST5-9**Students:* undertake firsthand investigations to collect valid and reliable data
* investigate how data is collected and managed by MedTech professionals to solve real-world challenges and improve decision making.
 | **Teacher****Revise investigation from previous lesson.****Student**Conduct adapted experiment to test the effect of different surfaces on friction or complete experiment from last lesson.**Teacher and students**Evaluate the experiment and collate results for analysis next lesson. | Students can undertake, evaluate and adjust firsthand investigations to gather data about different materials. | Assist students to safely and effectively undertake firsthand investigation.Provide a paper or digital worksheet and method if students require assistance with methodology. |
| **Weekly reflection** | **Students**Complete weekly reflection using the following steps:* identify tasks undertaken, new knowledge, understanding or skills
* evaluate new knowledge, understanding or skills in the light of previous knowledge.
 | Students answer reflective questions, for example:* What did I learn about investigations this week?
* Did I learn best when receiving information, applying knowledge, or communicating?
 | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.Reflection to be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Data analysis****ST5-9**Students:* use information computer technologies to assess data collected from firsthand investigations and other sources.
 | **Teacher****Demonstrate the use of a** spreadsheet program to collate and analyse data. Model the input of friction investigation data.**Demonstrate the creation of data visualisations, including the use of the mean and standard deviations.****Demonstrate the creation of a box and whisker plot and explain what the chart represents and evaluate the value of this visualisation.****Student**Analyse data set from firsthand investigation. Collate data and calculate the mean and standard deviation. **Students produce a box and whisker graph.**Compare results to determine a conclusion from the firsthand investigation. | Students can use a spreadsheet program to assess data collected from firsthand investigation. | Demonstrate the use of a spreadsheet program to assess a similar data set.Utilise accessibility options in Excel to support maximum student engagement. |
| **Evaluation****ST5-7**Students:* use project management and communication techniques to plan and document solutions.
 | **Teacher and student**Evaluate the impact this investigation may have on the prosthetic design.**Brainstorm and assess specific changes that can occur to the design and how these changes may be implemented, for example:*** **gluing rubber to fingers**
* **adding texture to fingertips.**

**Teacher**Review the role of iteration in the engineering design process.* Review engineering design process iterate questions with students, for example:
* If you decide to make revisions, what will it look like?
* Are there resources to make revisions?

**Student**Complete a critical evaluation of their prototype or partially completed prototype. | Students document their evaluation on how their prototype can change.Students demonstrate capacity to use evaluation to inform adaptation and iteration of their design.Students determine further materials they may need. | Provide possible iteration questions or template to scaffold potential changes.Provide iteration example to demonstrate planning for changes.Include multiple opportunities for students to respond, for example:* verbally
* individually
* partner turn and talk
* non-verbally
* gesture
* response cards.
 |
| **Iteration****ST5-6**Students:* design and build a system to solve a real-world MedTech problem.
 | **Teacher and students**Revise the use of slicing programs and prepare [3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/) files for printing, focussing on the wrist, thumb, and arm files at this stage.**Student**Download appropriate files and open in a familiar slicing program.Complete preparation of files for 3D printing and begin print. | Students can locate and manipulate appropriate files for CAD and CAM. | Use [Graduated Guidance [PDF 376KB]](https://education.nsw.gov.au/content/dam/main-education/campaigns/inclusive-education-hub/pdf/resources/Graduated_Guidance_Poster_FINAL_NSW_A4_-_TAGGED.pdf) to scaffold student independence when developing or practicing CAD skills. |
| **Weekly reflection** | **Students**Complete weekly reflection using the following steps:* identify tasks undertaken, new knowledge, understanding or skills
* evaluate new knowledge, understanding or skills in the light of previous knowledge.
 | Students answer reflective questions, for example:* What did I learn about this week?
* Did I learn best when receiving information, applying knowledge, or communicating?
 | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.Procedural recount to be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 7 and 8

Table 4 – MedTech weeks 7 and 8 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 7 –Wrist, thumb, and arm build****ST5-1, ST5-2**Students:* design and build a system to solve a real-world MedTech problem
* work individually and collaboratively to apply an engineering design process to complete problems and challenges.
 | **Teacher note****Conduct risk assessment before using equipment. Use hot glue guns or other strong and suitable adhesive instead of cyanoacrylates. Students cannot use** [super glue](https://ecmjsp.education.nsw.gov.au/ecmjsp/chemicals/?mode=viewchemares&chemalpha=C&chemid=576#skipToContent)**.****Teacher****Direct students to continue assembly of prosthetic including the thumb, wrist, and arm. Instruct students that week 8 will be used for installing and programming servos.**Revise instructions in [3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/).**Students****Use their 3D prints and materials** to build the remainder of the[3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/) **prosthetic prototype.****Teacher****Assist students in fabrication of their design using available resources. Prompt students to try different techniques when they encounter build problems.** | Students have constructed a physical prosthetic based on the instructions. | Actively assess student progress and assist where appropriate.Access [text version [PDF 1443KB]](https://content.instructables.com/pdfs/EOF/VXS8/J6WGY2E9/3D-Printed-Robotic-Hand.pdf) of instructions and adjust text to assist student understanding. |
| **Weekly reflection** | **Students**Complete weekly reflection using the following steps:* identify tasks undertaken, new knowledge, understanding or skills
* evaluate new knowledge, understanding or skills in the light of previous knowledge.
 | Students answer reflective questions, for example:* What did I learn about this week?
* Did I learn best when receiving information, applying knowledge, or communicating?
 | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.Procedural recount to be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 8 – Servos****ST5-6**Students:* code computer platforms to develop solutions in MedTech
* employ commonly used tools, equipment, and techniques to develop MedTech solutions, models, prototypes, or experiments.
 | **Teacher note: Conduct risk assessment before using equipment. Use hot glue guns or other glue types instead of cyanoacrylates. Do not use super glue.****Teacher****Direct students to continue assembly of prosthetic focussing in on the mechanics and servos.****Demonstrate the coding and electronic assembly that will be required.****Advise students that gluing may be a priority as it may need to set overnight.****Concentrate on one servo system working before attempting all servos.**Revise instructions in [3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/).**Teacher and students****Use servos and adhesives** to build the remainder of the[3D Printed Robotic Hand With Bluetooth Control](https://www.instructables.com/3D-Printed-Robotic-Hand/) **prosthetic prototype.** | Students have constructed a physical prosthetic based on the instructions.Students have assembled a working servomotor, nylon line and finger to gain movement in a digit. | Actively assess student progress and assist where appropriate.Access [text version [PDF 1443KB]](https://content.instructables.com/pdfs/EOF/VXS8/J6WGY2E9/3D-Printed-Robotic-Hand.pdf) of instructions and adjust text to assist student understanding. |
| **Weekly reflection** | **Students**Complete weekly reflection using the following steps:* identify tasks undertaken, new knowledge, understanding or skills
* evaluate new knowledge, understanding or skills in the light of previous knowledge.
 | Students answer reflective questions, for example:* What did I learn about servos this week?
* Did I learn best when receiving information, applying knowledge, or communicating?
 | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.Procedural recount to be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 9 and 10

Table 5 – MedTech weeks 9 and 10 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 9 – Evaluate, iterate, and communicate****ST5-1, ST5-2**Students:* demonstrate innovation and entrepreneurial activity and communicate solutions to problems involving MedTech.
 | **Teacher**Introduce real world testing of the prosthetic, for example:* Can the prosthetic hold a can?
* Can the prosthetic type on a computer keyboard?

**Teacher and students**Plan real world tests and brainstorm possible problems and solutions.**Student**Engage in real world testing of prosthetic.Conduct immediate alteration of prosthetic to troubleshoot issues that may arise. | Students can develop, conduct and record testing of device. Students demonstrate capacity to iterate device based on real-time evaluations. | Support students with the testing and immediate alteration of design.Model the documentation of student testing and their adjustments.  |
| **Share and learn****ST5-8**Students:* demonstrate innovation and entrepreneurial activity and communicate solutions to problems involving MedTech.
 | **Teacher and students****Share testing results and innovative iterations used to solve problems.**Conduct an overall evaluation of the prosthetic and document future possible directions for the design of the prosthetic.**Extension**This MedTech learning sequence could be combined with the PBL extension topic to action designs discussed in this lesson. | Students demonstrate capacity to test devices and share their test results.Students complete an overall evaluation based on design criteria. | Provide students with an evaluation scaffold. Demonstrate evaluation of devices and sharing of insights. |
| **Weekly reflection** | **Students**Complete weekly reflection using the following steps:* identify tasks undertaken, new knowledge, understanding or skills
* evaluate new knowledge, understanding or skills in the light of previous knowledge.
 | Students answer reflective questions, for example:* What did I learn about servos this week?
* Did I learn best when receiving information, applying knowledge, or communicating?
 | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.Procedural recount to be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 10 – Future of prosthetics****ST5-2**Students:* explore ethical and legal issues that affect MedTech innovations and practices
* develop an understanding of the current and emerging challenges faced by the MedTech industry
* demonstrate critical thinking skills to distinguish between facts and fallacy
* evaluate emerging MedTech innovations.
 | **Teacher**Present [Artificial touch technology restores feeling to prosthetic limbs (3:36)](https://www.youtube.com/watch?v=5-S3KB7gLeU). Describe the mechanical interface and dynamic interface of the prosthetic presented.**Teacher and student**Evaluate the video to determine any bias from the presenters or interviewees, for example:* **Were limitations of the technology presented?**
* **Was there an attempt to sell something?**
* **Was language used that persuaded your thinking?**

**Evaluate the video to determine if an ‘appeal to authority’ fallacy was employed, for example:*** **Was the opinion of an expert used to strengthen an argument *in the face of conflicting evidence*?**

View and assess videos that may be advanced computer graphics or real videos of automation, for example:* [Atlas | Partners in Parkour (1:05)](https://www.youtube.com/watch?v=tF4DML7FIWk)

Explore the legal and ethical perspectives of developing bionic artificial intelligence prosthetics. | Students can identify and describe emerging MedTech innovations, for example:* advanced prosthetics
* advanced interfaces.

Students can demonstrate critical thinking skills when accessing secondary sources of information.Students can determine that an expert was giving an opinion in the video but it was not in the face of conflicting evidence. | Pause video to assess student understanding, or highlight key advances, at appropriate points.Demonstrate critical thinking skills for students to assist with critical evaluation of sources of information, for example:* Who is producing this information?
* Do they gain anything by changing my opinion?
* What are alternative sources of information and do these sources corroborate this data?
 |
| **Command and control****ST5-2**Students:* explore ethical and legal issues that affect MedTech innovations and practices
* demonstrate critical thinking skills to distinguish between facts and fallacy
* evaluate emerging MedTech innovations.
 | **Teacher**Present [Magnetomicrometry-Based Control (2:35)](https://www.youtube.com/watch?v=bU2jEA6u2rk&t=138s). Explain the mechanical interface and dynamic interface of the prosthetic’s presented.Present [How to control someone else's arm with your brain | Greg Gage (5:52)](https://www.youtube.com/watch?v=rSQNi5sAwuc).**Teacher and student**Evaluate the video to distinguish evidence for claims that were made, for example:* Were claims made?
* Was evidence presented to support a claim?
* What was that evidence?

Explore key ethical or legal issues regarding advanced prosthetics and bionics, for example:* warfare
* sport
* consumerism
* equity and access
* damage caused by advanced prosthetics.
 | Students can identify and describe emerging MedTech innovations, for example:* advanced prosthetics
* advanced interfaces.

Students can identify and describe potential legal and ethical issues in MedTech.Students can demonstrate critical thinking skills when accessing secondary sources of information. | Use closed captions when viewing video to assist understanding and vocabulary building. Pause video to assess student understanding at appropriate points.Provide key terms to assist with vocabulary building and knowledge acquisition. |
| **Careers****ST5-10**Students:* engage in industry career development opportunities to gain a deeper knowledge of professions that utilise MedTech, develop skills, knowledge and understanding of authentic, real-world problem-solving
* investigate the nature of work and pathways into industries that support MedTech and related careers
* explain the effects of innovation on current and future MedTech careers.
 | **Teacher and students**View the career profile video of [Dr Anjali Jaiprakash - Robobiologist (3:12)](https://www.youtube.com/watch?v=Lvp1PzoPqx4) and [Entrepreneurs - Dr Kate Lomas, Biophysicist & Dr Liz Williams, Chemist (2:31)](https://www.youtube.com/watch?v=pl4TfapPwfk).Explore the STELR career profile website of [Dr Anjali Jaiprakash](http://stelr.org.au/career_profiles/anjali-jaiprakash/), [Dr Kate Lomas and Dr Liz Williams](http://stelr.org.au/career_profiles/kate-lomas-and-liz-williams/). Identify potential career pathways for medical technology careers.Explain the effects of innovation on current and future MedTech careers and determine skills and attributes that may be beneficial in this rapidly changing environment. | Students can identify potential education and career pathways for medical technology careers. | Create worksheets to highlight key information to gather from career webpages and videos.Use closed captions when viewing video to assist understanding and vocabulary building. Pause video to highlight and discuss key information at appropriate points. |
| **Weekly reflection** | **Students**Complete weekly reflection using the following steps:* identify tasks undertaken, new knowledge, understanding or skills
* analyse key insights and pose questions regarding their future learning.
 | Students answer reflective questions, for example:* What did I learn about this week?
* Did I learn best when receiving information, applying knowledge, or communicating?
 | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.Procedural recount to be prepared on paper or digitally, including speech-to-text or voice recording. |

## Reflection and evaluation

**Reflecting on and evaluating learning activities should be an ongoing process that happens throughout the delivery of this topic. Teachers should document their evaluation of learning activities throughout the program. The space below is provided to reflect on and evaluate this overall unit of work.**

## Additional information

**Resource evaluation and support**: Please complete the following [feedback form](https://forms.office.com/Pages/ResponsePage.aspx?id=muagBYpBwUecJZOHJhv5kbKo2q_ZUXlHndJMnh2Wd8NUOUk0VTIzUDVVSlVFQVM5MkdOMkJGTjVKNCQlQCN0PWcu) to help us improve our resources and support.

The information below can be used to support teachers when using this teaching resource for iSTEM.

### Assessment for learning

Possible formative assessment strategies that could be included:

* Learning intentions and success criteria assist educators to articulate the purpose of a learning task to make judgements about the quality of student learning. These help students focus on the task or activity taking place and what they are learning and provide a framework for reflection and feedback. [Online tools](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/622) can assist implementation of this formative assessment strategy.
* Eliciting evidence strategies allow teachers to determine the next steps in learning and assist teachers in evaluating the impact of teaching and learning activities. Strategies that may be added to a learning sequence to elicit evidence include all student response systems, [exit tickets](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/543), mini whiteboards (actual or [digital](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/575)), [hinge questions](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/560#.Y9w1CT4W5as.link), [Kahoot](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/621), [Socrative](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/587), or quick quizzes to ensure that individual student progress can be monitored and the lesson sequence adjusted based on formative data collected.
* Feedback is designed to close the gap between current and desired performance by informing teacher and student behaviour (AITSL 2017). AITSL provides a [factsheet to support evidence-based feedback](https://www.aitsl.edu.au/teach/improve-practice/feedback#:~:text=FEEDBACK-,Factsheet,-A%20quick%20guide).
* [Peer feedback](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/549) is a structured process where students evaluate the work of their peers by providing valuable feedback in relation to learning intentions and success criteria. It can be supported by [online tools](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Browser?cache_id=1d29b).
* Self-regulated learning opportunities assist students in taking ownership of their own learning. A variety of strategies can be employed and some examples include reflection tasks, [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645), [KWLH charts](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/562), [learning portfolios](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/583) and [learning logs](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/583).

The primary role of assessment is to establish where individuals are in their learning so that teaching can be differentiated and further learning progress can be monitored over time.

Feedback that focuses on improving tasks, processes and student self-regulation is the most effective. Students engaging with feedback can take many forms including formal, informal, formative, summative, interactive, demonstrable, visual, written, verbal and non-verbal.

[What works best update 2020](https://education.nsw.gov.au/about-us/educational-data/cese/publications/research-reports/what-works-best-2020-update) (CESE 2020a)

### Differentiation

Differentiated learning can be enabled by differentiating the teaching approach to content, process, product and the learning environment. For more information on differentiation go to [Differentiating learning](https://education.nsw.gov.au/teaching-and-learning/professional-learning/teacher-quality-and-accreditation/strong-start-great-teachers/refining-practice/differentiating-learning) and [Differentiation](https://education.nsw.gov.au/campaigns/inclusive-practice-hub/secondary-school/teaching-strategies/differentiation).

When using these resources in the classroom, it is important for teachers to consider the needs of all students in their class, including:

* **Aboriginal and Torres Strait Islander students**. Targeted [strategies](https://education.nsw.gov.au/teaching-and-learning/aec/aboriginal-education-in-nsw-public-schools) can be used to achieve outcomes for Aboriginal students in K-12 and increase knowledge and understanding of Aboriginal histories and cultures. Teachers should utilise students’ Personalised Learning Pathways to support individual student needs and goals.
* **EAL/D learners**. EAL/D learners will require explicit English language support and scaffolding, informed by the [EAL/D enhanced teaching and learning cycle](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/resources-for-schools/eald/enhanced-teaching-and-learning-cycle) and the student’s phase on the [EAL/D Learning Progression](https://education.nsw.gov.au/teaching-and-learning/curriculum/multicultural-education/english-as-an-additional-language-or-dialect/planning-eald-support/english-language-proficiency). In addition, teachers can access information about [supporting EAL/D learners](https://education.nsw.gov.au/teaching-and-learning/curriculum/multicultural-education/english-as-an-additional-language-or-dialect/planning-eald-support/english-language-proficiency) and [literacy and numeracy support specific to EAL/D learners](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/resources-for-schools/eald).
* **Students with additional learning needs**. Learning adjustments enable students with disability and additional learning and support needs to access syllabus outcomes and content on the same basis as their peers. Teachers can use a range of [adjustments](https://education.nsw.gov.au/teaching-and-learning/disability-learning-and-support/personalised-support-for-learning/adjustments-to-teaching-and-learning) to ensure a personalised approach to student learning. In addition, the [Universal Design for Learning planning tool](https://education.nsw.gov.au/teaching-and-learning/learning-from-home/teaching-at-home/teaching-and-learning-resources/universal-design-for-learning) can be used to support the diverse learning needs of students using inclusive teaching and learning strategies. Subject specific curriculum considerations can be found on the [Inclusive Practice hub](https://education.nsw.gov.au/campaigns/inclusive-practice-hub)..
* **High potential and gifted learners**. [Assessing and identifying high potential and gifted learners](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/assess-and-identify#Assessment1) will help teachers decide which students may benefit from extension and additional challenge. [Effective strategies and contributors to achievement](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/evaluate) for high potential and gifted learners help teachers to identify and target areas for growth and improvement. In addition, the [Differentiation Adjustment Tool](https://education.nsw.gov.au/teaching-and-learning/high-potential-and-gifted-education/supporting-educators/implement/differentiation-adjustment-strategies) can be used to support the specific learning needs of high potential and gifted students. The [High Potential and Gifted Education Professional Learning and Resource Hub](https://schoolsnsw.sharepoint.com/sites/HPGEHub/SitePages/Home.aspx) supports school leaders and teachers to effectively implement the High Potential and Gifted Education Policy in their unique contexts.

All students need to be challenged and engaged to develop their potential fully. A culture of high expectations needs to be supported by strategies that both challenge and support student learning needs, such as through appropriate curriculum differentiation. (CESE 2020a:6).

### About this resource

All curriculum resources are prepared through a rigorous process. Resources are periodically reviewed as part of our ongoing evaluation plan to ensure currency, relevance and effectiveness. For additional support or advice contact the Teaching and Learning Curriculum team by emailing secondaryteachingandlearning@det.nsw.edu.au.

**Alignment to system priorities and/or needs**:

This resource aligns to the School Excellence Framework elements of curriculum (curriculum provision) and effective classroom practice (lesson planning, explicit teaching).

This resource supports teachers to address Australian Professional Teaching Standards 2.1.2, 2.3.2, 3.2.2, 7.2.2

This resource has been designed to support schools with successful implementation of new curriculum, specifically the NSW Department of Education approved elective course, iSTEM© 2021 NSW Department of Education for and on behalf of the Crown in right of the State of New South Wales.

The resource is produced to assist schools with promoting and implementing the course for the first time. As the course may be taught by teachers from a range of key learning areas, the resource is designed to support teachers from a variety of KLA expertise.

**Department approved elective course**: iSTEM

**Course outcomes**: ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-8, ST5-9, ST5-10

**Author**: Curriculum Secondary Learners

**Publisher**: State of NSW, Department of Education

**Resource**: Teaching resource

**Related resources**: Further resources to support iSTEM can be found on the Department approved elective courses webpage including course document, sample scope and sequences, assessment materials and other learning sequences.

**Professional Learning**: Join the [Teaching and Learning 7-12 statewide staffroom](https://education.nsw.gov.au/teaching-and-learning/curriculum/statewide-staffrooms) for information regarding professional learning opportunities.

**Universal Design for Learning Tool**: [Universal Design for Learning planning tool](https://education.nsw.gov.au/teaching-and-learning/learning-from-home/teaching-at-home/teaching-and-learning-resources/universal-design-for-learning). Support the diverse learning needs of students using inclusive teaching and learning strategies.

**Consulted with**: Aboriginal Outcomes and Partnerships, Inclusion and Wellbeing, EAL/D, Registered Chiropractor, Science Teaching Methods Coordinator University of Technology, Sydney.

**Reviewed by**: This resource was reviewed by Curriculum Secondary Learners and by subject matter experts in schools to ensure accuracy of content.

**Creation date**: 15 November 2022

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**Evidence Base**:

‘The long-term vision is for a curriculum that supports teachers to nurture wonder, ignite passion and provide every young person with knowledge, skills and attributes that will help prepare them for a lifetime of learning, meaningful adult employment and effective future citizenship’ (NESA 2020:xi).

The development of the course and the course document as part of department approved electives aims to respond to the goals articulated in NESA’s curriculum review. Consistent messages from the review include:

* ‘flexibility’ was the word most used by teachers to describe the systemic change they want
* teachers need more time to teach important knowledge and skills
* students want authentic learning with real-world application.

This teaching resource provides teachers with some examples of explicit and authentic learning experiences. The option to adjust these learning sequences leads to ‘increased local decision making in relation to the curriculum’ as this ‘is associated with higher levels of student performance’ (NESA 2020:52).

The suggested strategies for teaching and learning align with the principles of explicit teaching. ‘The evidence shows that students who experience explicit teaching practices perform better than students who do not. Explicit teaching reduces the cognitive burden of learning new and complex concepts and skills, and helps students develop deep understanding’ (CESE 2020a:11).

## References

**Links to third-party material and websites**

Please note that the provided (reading/viewing material/list/links/texts) are a suggestion only and implies no endorsement, by the New South Wales Department of Education, of any author, publisher or book title. School principals and teachers are best placed to assess the suitability of resources that would complement the curriculum and reflect the needs and interests of their students.

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### Further reading

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