# iSTEM – project-based learning: Will any robot do?



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## Project-based learning: Will any robot do?

Project-based learning is an approach to teaching and learning that engages students in rich and authentic learning experiences. It is a transformative teaching practice that requires a commitment to innovation and contemporary pedagogies. In project-based learning environments, students gain knowledge and skills by investigating and responding to engaging questions, problems or challenges.

In this core topic, students develop and realise solutions to STEM focused project-based learning tasks. It requires students to utilise problem-solving strategies to apply appropriate design, production and evaluation skills to real-world problems. Teachers are encouraged to use project-based learning pedagogies to extend student centred learning opportunities across a range of specialised topics. Teachers may choose to select problems which are relevant to local school contexts.

To complete this topic, students should follow design thinking processes. Curriculum Secondary Learners have produced an iSTEM engineering design process and engineering report guide to provide a scaffold that will engage students in their personal learning journey.

### Duration of learning

Indicative time – 25 hours.

### Inquiry question

How effective are robots in testing accessibility?

### 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.

[iSTEM course document](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem%22%20%5Cl%20%22/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. Core modules must precede options in the delivery of the course. Consult the course document for further details on timing of core and options.

## 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 for adjustments and enhancements that are made to the learning sequence during its implementation 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

Engineering design challenges support the development of curiosity, creativity and persistence in students. Design challenges are hands-on projects based on real-world science and engineering.

Table 1 – project-based learning: Will any robot do? Weeks 1 and 2 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 1 – introduction and issues****ST5-5, ST5-10**Students:* utilise components of a design process
* define problems or needs to gain understanding of requirements.
 | **Teacher**Introduce inquiry question: How effective are robots in testing accessibility?Introduce engineering design challenge(s) and relevant context. Design challenges could include:* DIY telepresence robot
* design, prototype and build modifications for an existing robot.
* design and conduct investigations to review and report on physical accessibility to a range of school rooms
* design and prototype (and build) a standards compliant ramp to improve accessibility.

**Teacher and students**Explore benefits for people with restricted mobility using:* ramps and elevators
* telepresence robots
* electric wheelchairs.

Analyse existing solutions and identify relevant issues and engineering principles to research. | Students actively participate in class discussions.Students can explain the benefits for people with restricted mobility for at least one of the following:* ramps
* elevators
* telepresence robots
* electric wheelchairs.
 | Students are given verbal and non-verbal options to describe the design challenge. |
| **Laws and regulations****ST5-5**Students:* define problems or needs to gain understanding of requirements
* identify constraints and outline the scope for which the project will be confined.
 | **Teacher**Outline issues of equity of access to goods, services and facilities, for example:* [proportion of population with diagnosed disability](https://www.aihw.gov.au/reports/disability/people-with-disability-in-australia/contents/people-with-disability/prevalence-of-disability)
* legislation
* costs (for the individual and community).

Outline the Acts, Regulations and design responsibilities relevant to building access, for example:* [Disability Discrimination Act 1992](https://humanrights.gov.au/our-work/disability-rights/brief-guide-disability-discrimination-act) (DDA)
* [National Construction Code](https://ncc.abcb.gov.au/) (was Building Code of Australia)
* [Premises Standards](https://www.industry.gov.au/building-and-construction/premises-standards)
* Access Code
* Workplace Health and Safety (WHS)
* State and Territory building legislation
* Australian Standards ([summary provided [PDF 72.8 KB]](https://www.aph.gov.au/parliamentary_business/committees/house_of_representatives_committees?url=laca/disabilitystandards/exhibits/exhibit02.pdf)).

**Students**Identify legal requirements for accessibility in public buildings.**Teacher and students**Examine privacy issues within the context of telepresence robots providing remote access into buildings.**Teacher**Introduce robot(s) to be used for design challenge and/or to assess physical accessibility of (school) buildings. | Students will be able to demonstrate awareness of the regulations around access to public buildings.Students can outline some privacy issues associated with the use of telepresence robots. | (Add adjustments and registration) |
| **Traditional perspectives****ST5-5**Students:* examine traditional technologies used by Aboriginal and Torres Strait Islander peoples to solve problems
* examine traditional techniques and perspectives used by Aboriginal and Torres Strait Islander peoples to solve problems.
 | **Teacher and students**Investigate Aboriginal and/or Torres Strait Islander watercraft culture and the construction of [canoes](https://australian.museum/learn/cultures/atsi-collection/sydney/about-canoes/).Identify the importance of understanding your local environment and conditions.Explain the importance of using the right materials at the right time.Use traditional perspectives and apply to the current telepresence robot design challenge, for example:* understand the local environment
* use available materials.
 | Students can identify the importance of understanding their local environment and conditions.Students can explain the importance of evaluating the use of materials within a given context. | Student options provide for multiple means of expression for explaining the importance of contextual evaluation of material use. |
| **Coding – learn to drive (basic operations)****ST5-5**Students:* investigate information communication technologies, tools, materials, and processes to produce a solution to an identified problem
* develop and evaluate creative, innovative and enterprising design ideas and solutions to a range of problems.
 | **Teacher**Demonstrate how to operate the robot and/or control it with program code.Explain how to construct simple algorithms to move the robot using the sequence control structure.Explain components of programming language to be used.Demonstrate how to write code that instructs the robot to perform set simple tasks, and the process to upload code to the robot.**Students**Construct and check algorithms to perform simple movement tasks, for example:* move forward set distance
* move forward and then back to starting position
* move forward and turn.

Write code, debug and upload to the robot.Test robot functions correctly and modify as necessary. | Students can successfully code the robot to accomplish a series of navigational movements to travel from an initial point to a destination.Students will have written and checked algorithms that correctly represent the instructions a robot will need to perform simple set tasks.Students can translate algorithms into text-based code and demonstrate their ability to correct any syntax errors.Students can successfully upload code to the robot, test its functionality and correct any logical errors. | Model the use of code to complete challenges. Provide examples that students can modify to create successful movement.Provide visual and/or multimedia examples and check understanding of concepts.During practical learning activities, use and emphasise target language required and encourage students to use this language in context.The language required should be taught explicitly with opportunities for guided practice. |
| **Weekly reflection** | **Teacher**Monitor the progress of student knowledge and skills from reflections.**Students**Complete weekly reflection identifying tasks undertaken, new knowledge, understanding or skills. | Students answer reflective questions, for example:* What new knowledge, skills and language did I learn this week, and how might these assist me in completing my project on robots?
 | A procedural recount can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 2 – coding planned paths****ST5-5**Students:* investigate information communication technologies, tools, materials, and processes to produce a solution to an identified problem
* develop and evaluate creative, innovative and enterprising design ideas and solutions to a range of problems.
 | **Teacher**Set more complex challenges, for example, code the robot to move:* forward set distance and return to initial spot
* forward x, turn left/right, forward y
* around the perimeter of a two-dimensional shape.

**Students**Write algorithms and code robots to complete more complex challenges.Test code, evaluate results and modify as necessary.**Teacher**Demonstrate how to measure the time taken to travel a set distance in a straight line using (with code) a set speed setting.Explain how to calculate the speed (velocity) from the time taken to travel a set distance using:$$velocity=\frac{distance}{time}$$**Students**Record the time taken for the robot to move in a straight line at a set distance with different speed settings.Calculate the maximum speed of the robot in metres per second on a level surface.**Extension (optional)**Compare the results of different robots using a chart.Students construct simple ramps of set length. Record the time taken for the robot to move a set distance with different angles of inclination and different speed settings.Calculate the maximum speed of the robot in metres per second on various inclined ramps. | Students can successfully code the robot to accomplish a series of navigational movements to travel from an initial point to a destination. | Model the use of code to complete more complex challenges. Provide examples that students can modify to create successful movement.Provide visual and/or multimedia examples and check understanding of concepts.During practical learning activities, use and emphasise target language required and encourage students to use this language in context.The language required should be taught explicitly in context with multiple opportunities for guided practice. |
| **2D representations – maps and scale diagrams****ST5-4, ST5-5**Students:* analyse data to inform decisions and draw conclusions, using a range of evaluation techniques
* investigate information communication technologies, tools, materials, and processes to produce a solution to an identified problem.
 | **Teacher**Present aerial maps and/or plans of the school, for example:* asset management system (AMS)
* Google Maps
* Spatial Information Exchange (SIX) maps.

Review the concept of scale (map scale) and demonstrate how to read scale on a map or plan and how to determine the actual distance between 2 points represented on a map.Select the front office entry as a starting point and a destination within the school, and demonstrate how to measure the distance between the 2 points, for example:* a particular classroom
* school library.

**Students**Identify a range of destinations within the school and calculate approximate distances from front (administration) office entry to each destination.**Teacher**Outline some strategies to measure the actual distances.**Teacher and students**Measure the actual distances and compare with calculations from scale maps and note level of accuracy. | Students can use appropriate equipment to sketch an appropriately scaled 2D map of a given area/route | Limit choice of locations students measure the distance between and/or provide measurements to use for calculations and comparisons. |
| **2D representations – bearings and coordinates****ST5-4, ST5-5, ST5-8**Students:* demonstrate ability to communicate design ideas using a range of drawing techniques as described in the STEM fundamentals core topic
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Review bearings and coordinates and their application on maps.**Students**Identify the coordinates of a structure or feature within the school, for example:* front office doorway
* fence post
* corner of building.

Calculate bearings from one location to another, for example:* school gate to front office
* sections of a pathway
* walls of buildings.
 | Students can use appropriate equipment to record bearings from one location to a straight-line destination.Students will be able to combine bearings of several links to calculate overall bearing from starting location to final destination. | (Add adjustments and registration) |
| **Defining the best route****ST5-4**Students:* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Review methods of calculating distances of routes in 2 dimensions, including:* using maps or floor plans of school
* measuring tools.

Describe methods of calculating distances of routes in 3 dimensions, for example:* length of ramps and other sloped surfaces
* calculating difference in elevation
* vertical movement in elevators if available
* any additional measuring tools or technologies.

**Students**Identify a typical route from the front office to the chosen destination.Identify waypoints along this route and sections where the elevation changes.Calculate the distance and approximate travel time based on the speeds calculated previously.**Teacher and students**Discuss whether the shortest route can be the most accessible.Using the [DDA](https://humanrights.gov.au/our-work/disability-rights/dda-guide-ins-and-outs-access) as a guide, assess various routes with the same start and finish locations to determine the route that has the least barriers to access for a person who uses a wheelchair or mobility device. | Students can use maps and appropriate measuring equipment to calculate the distance of at least 2 different routes from a fixed starting point to a destination.Students have taken into consideration changes in elevation when calculating the distance to be travelled.Students can calculate the approximate time to travel the distance based on a known speed of the robot.Students will be able to articulate the intent of the DDA as it applies to people with disability accessing buildings.Students can assess which route is the most accessible for people with restricted mobility. | Provide visual and/or multimedia examples and check understanding of concepts.Ensure all students understand both technical and culturally based terms. |
| **Weekly reflection** | **Teacher**Monitor the progress of student reflections.**Students**Complete weekly reflection evaluating new knowledge, understanding or skills in relation to previous knowledge. | Students will demonstrate the impact of these learning events or activities by making judgments about what has happened and what they still need to understand. | A procedural recount can be prepared on paper or digitally, including speech-to-text or voice recording.Give question prompts or sentence starters to help students respond. |

### Week 3

Choose mathematical skills and techniques appropriate to your students’ design challenge and/or context.

Table 2 – project-based learning: Will any robot do? Weeks 3 and 4 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 3 – Code for a destination****ST5-1, ST5-2, ST5-4, ST5-5**Students:* demonstrate ability to communicate design ideas using a range of drawing techniques as described in the STEM fundamentals core topic
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Review programming language features necessary to code the robot for the selected route (multi-leg journey).**Students**Design an algorithm for the robot to travel from the front office to a chosen destination.Program the robot to travel the selected route. Test for syntax and logic errors.Modify code as necessary to successfully travel the route in one continuous sequence. | Students can design and modify code as necessary to successfully travel route in one continuous sequence. | Provide visual and/or multimedia examples and check understanding of concepts.Ensure all students understand both technical and culturally based terms. |
| **Gradients and ratios****ST5-4, ST5-5, ST5-9**Students:* collect and organise data in a range of formats
* analyse data to inform decisions and draw conclusions, using a range of evaluation techniques
* identify and use a broad range of problem-solving strategies in the development of practical solutions to project-based learning tasks.
 | **Teacher**Outline laws, regulations and building standards for internal and external ramps in public buildings.Define terms:* accessibility ramp
* kerb ramp
* step ramp
* high step ramp
* threshold ramp
* switchback
* landing.

State [maximum allowed gradients](https://designfordignity.com.au/retail-guidelines/dfd-06-10-ramps-landings-and-walkways.html) and maximum rise for various ramp types.Demonstrate how to calculate the minimum required horizontal length of ramp for a range of given ramp heights, for example:* 180 mm
* 500 mm
* 1000 mm.

**Students**Calculate the horizontal length of example ramps.**Teacher**Outline the standards for when a ramp changes direction, for example:* 90-degree turn
* 180-degree turn (switchback).

**Students**For given scenarios, calculate the required ramp which complies with building standards.Sketch diagrams of the ramp solution. | Students can recall the definitions of a range of terms related to building standards of ramps.Students can recall the maximum allowed gradients and maximum rise of the various ramp types.Students can calculate the length of ramps based on the building standards rules and given ramp heights.Students will have produced annotated sketches of ramps for various scenarios. | Prepare scaffolded worksheet to assist gradual student independence with mathematical problem-solving. |
| **Pythagoras****ST5-4, ST5-5**Students:* identify and use a broad range of problem-solving strategies in the development of practical solutions to project-based learning tasks.
 | **Teacher**Review Pythagoras theorem and how it can be used to determine the third side of a right-angled triangle when the other 2 sides are known.Demonstrate how to use Pythagoras theorem to calculate the hypotenuse of example right-angled triangles.Explain how the length of a ramp is the hypotenuse of a right-angled triangle.**Students**Calculate the hypotenuse of given triangles.Calculate the ramp length (hypotenuse) given ramp height and horizontal length. | Students can identify right-angled triangles from amongst other triangles and can identify the hypotenuse of a right-angled triangle.Students can calculate the length of a hypotenuse using Pythagoras’ theorem given the lengths of the other 2 sides of a right-angled triangle. | Prepare scaffolded worksheet to assist gradual student independence with mathematical problem-solving. |
| **Trigonometry****ST5-4, ST5-5**Students:* identify and use a broad range of problem-solving strategies in the development of practical solutions to project-based learning tasks.
 | **Teacher**Review relevant trigonometry functions and how they are used to determine the angles of a right-angled triangle when the other 2 sides and an angle are known.Demonstrate how to use trigonometry to calculate:* angle
* side.

**Students**Use trigonometric functions to calculate unknown angles or sides of right-angled triangles. | Students can select the correct trigonometric functions to calculate either unknown angles or unknown sides of right-angled triangles if provided with 2 sides, or one side and one angle. | Prepare scaffolded worksheet to assist gradual student independence with mathematical problem-solving. |
| **Weekly reflection** | **Teacher**Monitor the progress of student reflections.**Students**Complete weekly reflection identifying tasks undertaken, new knowledge, understanding or skills. | Students answer reflective questions, for example:* What did I learn about this week?
 | A procedural recount can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Week 4

**Note:** Three options are provided for this section, computer-aided design (CAD), photogrammetry and cardboard prototyping.

Table 3 – project-based learning: Will any robot do? Weeks 3 and 4 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 4 – CAD floor plans****ST5-4, ST5-5, ST5-8**Students:* investigate information communication technologies, tools, materials, and processes to produce a solution to an identified problem
* evaluate the benefits of using information communication technologies to solve problems.
 | **Teacher**Demonstrate how to use CAD software to draw scale diagrams of floor plans.**Students**Draw scale diagrams of floor plans using CAD software which cover the area of interest (destinations) within the school.**Teacher**Outline the concept of digital 3D models used for modelling processes and as tools for generating solutions to challenges, for example:* [NSW Spatial Digital Twin](https://www.spatial.nsw.gov.au/digital_twin).

**Teacher and students**Using representations like Venn diagrams evaluate advantages and disadvantages of digital models and analogue models. | Students have created scale 2D floor plans of school buildings within CAD software using standard conventions and with appropriate detail. | Consider accessibility needs and check for built-in features when using selected CAD software and hardware.Provide templates for graphic organisers to organise student knowledge of advantages and disadvantages. |
| **Option A:****3D representations in CAD****ST5-4, ST5-5, ST5-8**Students:* communicate solutions to problems through information communication technologies.
 | **Teacher**Demonstrate how to convert a 2D floorplan of a school building into a scale 3D model.**Students**Construct a scale 3D model in CAD for the area of interest within the school. | Students will have created parts of 3D models of school buildings within CAD software. The models demonstrate correct scale and proportions. | Provide scaffold or instructions to assist with process-based activities. |
| **Option A:****3D representations in CAD****ST5-4, ST5-5, ST5-8**Students:* communicate solutions to problems through information communication technologies.
 | **Teacher**Demonstrate how to use CAD software to save a variety of formats for any of the following purposes:* printing plans
* 3D printing (.STL files)
* laser cutting
* reference images for folio.

Demonstrate examples of 3D printed ramps and laser cut models.**Students**Continue with CAD design work.Develop 3D models of individual school buildings and/or whole school site.**Teacher**Organise and facilitate safe fabrication processes, which may include:* 3D printing
* laser cutting.

**Extension (optional)**Select a site for a proposed ramp and begin to take measurements to generate designs for ramp(s) in CAD software.Create a fly-through animation showing movement along chosen pathway. | Students will have created scale 3D models of school buildings within CAD software. The models demonstrate correct scale and proportions. | During practical learning activities, use and emphasise target language required and encourage students to use this language in context.The language required should be taught explicitly with opportunities for guided practice. |
| **Option B: 3D modelling with photogrammetry****ST5-4, ST5-6, ST5-8**Students:* investigate information communication technologies, tools, materials, and processes to produce a solution to an identified problem
* communicate solutions to problems through information communication technologies.
 | **Teacher**Demonstrate how to use photogrammetry software and collect image data for an area of interest within the school.**Students**Use photogrammetry software to collect image data for area of interest, including stairways, approaches and surrounds as appropriate.**Teacher**Demonstrate how to convert image data into 3D model/point cloud.Demonstrate how to georeference models to allow accurate measurements to be made.**Students**Convert image data into 3D model/point cloud. Perform any necessary georeferencing procedures. | Students will have collected image data of school buildings or specific sections of the planned paths using photogrammetry technology.Students will have generated a 3D model/point cloud using this data.Students can recall the processes to use photogrammetry technology to create 3D models. | Consider accessibility needs and check for built-in features when using selected photogrammetry software and hardware. |
| **Option B: 3D modelling photogrammetry****ST5-4, ST5-6, ST5-8**Students:* investigate information communication technologies, tools, materials, and processes to produce a solution to an identified problem
* communicate solutions to problems through information communication technologies.
 | **Teacher**Demonstrate how to use digital 3D models/point clouds to accurately perform measurements.**Students**Develop digital 3D models of individual school buildings and/or whole site.Record accurate measurements from the digital models for later use.**Extension (optional)**Create a fly-through animation of the path chosen from front office entry to the chosen destination. | Students will have created 3D models of school buildings or specific sections of the planned paths using photogrammetry technology.Students are able to record accurate measurements off the 3D model that match the physical location in the school within the accepted limits of accuracy. | Provide scaffold or instructions to assist with process-based activities. |
| **Option C: Physical 3D modelling (cardboard prototyping)****ST5-4, ST5-6, ST5-8**Students:* utilise components of a design process.
 | **Teacher**Review concepts of scale models.**Students**Develop 3D scale models of individual school buildings and/or whole site using available materials, for example:* cardboard
* corrugated plastic sheet
* plywood.
 | Students will have produced physical scale models of the school buildings of specific areas of interest in the school. | Provide scaffold or instructions to assist with process-based activities. |
| **Weekly reflection** | **Teacher**Monitor the progress of student reflections.**Students**Complete weekly reflection evaluating new knowledge, understanding or skills in relation to previous knowledge. | Students will demonstrate the impact of these learning events or activities by making judgments about what has happened and what they still need to understand. | Modelling of the reflective process may assist with the metacognitive aspects of this task. |

### Weeks 5 to 8

**Note:** Two options are provided for this section. Either option can be modified using a structured, guided or open inquiry-based learning approach (Banchi and Bell 2008).

Option A is written as a guided inquiry learning experience using an engineering design process to design and prototype modifications to augment an existing robot with the functionality of a telepresence robot to increase accessibility for people with mobility challenges.

Table 4 – project-based learning: Will any robot do? Weeks 5 to 8 learning sequence (option A)

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Option A: DIY Telepresence robot****ST5-2, ST5-3, ST5-4, ST5-5, ST5-7**Students:* utilise components of a design process.
 | **Teacher**Review design challenge, sources of information and results from mathematics and modelling activities (CAD or photogrammetry).Describe functions and characteristics of telepresence robots.Explain social and practical challenges encountered by operators and people physically present with the robots, and the implications for the design of telepresence robots.**Teacher and students**Review examples and existing use cases of telepresence robots, for example:* [Ohmni telepresence robot (0:30)](https://www.youtube.com/watch?v=D1ljQj203v4)
* [telepresence robots in action (2:37)](https://www.youtube.com/watch?v=mZ22wi-nyfg)
* [telepresence in the NSWDoE (6:12)](https://www.youtube.com/watch?v=etaSKVBkuQA)
* [teaching and learning with telepresence [PDF 2.4 MB]](https://e.issuu.com/embed.html?d=telepresencebrochure&u=technology4learning).
 | Students can articulate the intent of using telepresence robots to improve accessibility for people with restricted mobility.Students can describe the design challenge and link previous activities to this context. | (Add adjustments and registration) |
| **Define****ST5-2, ST5-3, ST5-4, ST5-5, ST5-7**Students:* utilise components of a design process
* define problems or needs to gain understanding of requirements.
 | **Teacher and students**Analyse the challenge and identify the group of people and their needs who would benefit from using telepresence robots.**Teacher**Select relevant questions from the engineering design process guide.**Teacher and students**Discuss questions and examine related issues.**Students**Review existing knowledge of the problem and its context.Mind map initial thoughts and additional questions related to the challenge.Write a clear statement describing the problem to be solved.**Teacher**Define success criteria for the project.**Students**Write a clear and concise design brief statement. | Students will have created a mind map representing their thinking processes, including their understanding of:* the problem to be solved
* additional questions to be answered.

Students have refined the design brief into a concise statement.Students can express their understanding of the success criteria. | Carry out a joint writing activity before students are expected to write independently. |
| **Brainstorm****ST5-3, ST5-4, ST5-8**Students:* brainstorm and generate ideas
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Define and compare [divergent and convergent thinking](https://www.youtube.com/watch?v=cmBf1fBRXms).Explain the importance of thinking about ‘the possible’ before thinking about limitations and constraints.Outline some rules to guide and promote good brainstorming practice.**Students**Use divergent thinking to produce as many creative ideas about the design challenge as possible.Produce thumbnail sketches and annotated drawings of initial ideas.**Teacher and students**Check for connections and relationships between generated ideas and merge where appropriate.**Students**Communicate and share ideas with class. | Students have produced a range of annotated sketches of possible designs.Students actively participate in class discussion and sharing of ideas. | During practical learning activities, use and emphasise target language required and encourage students to use this language in context.Consider student needs and alternative options when using thinking activities and graphical organisers for brainstorming.Model how to complete whatever graphic organiser is used, as students may not be familiar with these learning tools.Include multiple opportunities to respond, for example:* verbally
* individually
* partner turn and talk.
* nonverbally
* gesture
* response cards.
 |
| **Identify – capabilities and constraints****ST5-2, ST5-3, ST5-4, ST5-5, ST5-7**Students:* utilise components of a design process
* identify constraints and outline the scope for which the project will be confined.
 | **Teacher**Describe some typical scenarios the robot might face when travelling and get students to predict the outcomes.**Students**Predict potential outcomes of robot travelling in given scenarios.**Teacher**Explain the requirements, and relevance, to consider for the robot to travel required distances and negotiate slopes or ramps, for example:* maximum range of the robot
* maximum incline
* sufficient power and locomotion
* sufficient traction
* ramp surfaces to provide enough grip (friction)
* understanding centre of gravity to prevent it from toppling over.

**Students**Analyse all functions and capabilities of the robot.Identify and assess known constraints, which may include:* power requirements
* capacity for additional components
* construction materials.

Identify data and information that needs to be collected.Identify milestones for the project.Measure dimensions of robot components, including mass. | Students can clearly identify relevant constraints.Students have accurately collected measurements of components and produced a list of required dimensions.Students have used this information to inform their decision making and recorded any design thinking processes (including additional annotations on sketches). | Model the identification and assessment of constraints. |
| **Identify – hazards and safe operation****ST5-2, ST5-3, ST5-4, ST5-5, ST5-7**Students:* utilise components of a design process.
 | **Teacher**Identify implications for design of telepresence robots, for example:* awareness of robot’s location and state
* perception of hazards
* robot interactions with humans.

**Students**Describe sources of robot hazards, for example:* human errors
* control errors
* unauthorized access
* mechanical hazards
* environmental hazards
* electric power sources.

Identify safety issues using telepresence robots in schools.**Extension (optional)**Perform a hazard analysis of a telepresence robot. | Students can articulate safety requirements of each piece of technology to be used.Students have performed a hazard analysis of a telepresence robot. | Model the hazard analysis process with specific reference to a template or scaffold. |
| **Design****ST5-1, ST5-2, ST5-3, ST5-4, ST5-8**Students:* design solutions, synthesise ideas and plan
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Review existing understanding of convergent thinking.**Students**Use convergent thinking to develop ideas from brainstorming and identifying stages to refine solutions.**Teacher**Describe the need for, bidirectional audio and video feeds in telepresence robots.Demonstrate concepts for telepresence, for example:* height adjustable cameras and monitors
* field of view
* built-in obstacle avoidance.

**Students**Enhance and refine solutions based on this additional information.Produce sketches, detail drawings and/or digital graphics to communicate solutions. | Students have produced technical drawings (potentially even using CAD) of their designs. Multiple versions of designs with notes about modifications would indicate students’ iterative design processes. | (Add adjustments and registration) |
| **Prototype****ST5-3, ST5-4, ST5-6**Students:* prototype design solutions
* construct models and prototypes using a variety of media
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Outline the purpose of prototyping design ideas.Review identified requirements and success criteria.Explain the concept of prototype fidelity.**Teacher and students**Decide the fidelity required for this design challenge.**Teacher**Facilitate the use of tools and equipment by the students while providing active supervision.**Students**Use appropriate tools and materials to produce models and/or prototypes that demonstrate the aesthetic and functional attributes established in the design phase.**Extension (optional)**Include ergonomic considerations when building prototype. | Students can describe the relevant aspects of prototype fidelity and what level of detail and functionality are required.Students have collaboratively determined the level of prototype fidelity required to evaluate design considerations.Students have constructed a prototype which can demonstrate the necessary aesthetics and functional requirements. | (Add adjustments and registration) |
| **Evaluate prototype****ST5-3, ST5-4, ST5-5, ST5-9**Students:* utilise components of a design process
* evaluate solutions
* collect and organise data in a range of formats
* analyse data to inform decisions and draw conclusions, using a range of evaluation techniques
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Review [engineering design processes [PDF 1.09 MB]](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-engineering-design-process.pdf) completed to date.Emphasise the iterative nature of an engineering design process and outline the practice of evaluating and modifying prototypes.Review concepts of independent, dependent and controlled variables.Supervise groups planning and conducting investigations and/or experiments.**Students**Determine fair and reasonable tests which demonstrate compliance with identified requirements and success criteria.Plan and conduct (an) independent investigation(s) to test the prototype, for example:* test the functioning of added components
* test modified robot capabilities against previously established requirements like range and maximum incline
* test the ability of the modified robot to allow communication between remote operators and people near the robot
* test the structural integrity of their robot modifications
* design and construct any required test apparatus.

Collect, organise and interpret data to inform and evaluate design decisions.Iterate as necessary the processes of evaluating design decisions, implementing design modifications and further testing.**Extension (optional)**Include ergonomic attributes when evaluating the prototype. | Students can design a viable firsthand investigation with accurate independent, dependent and controlled variables.Students demonstrate practical skills by safely using appropriate tools, equipment and scientific methods to undertake firsthand investigation.Students demonstrate capacity to accurately assess data to draw conclusions or produce further questions. | (Add adjustments and registration) |
| **Share findings****ST5-2, ST5-3, ST5-4, ST5-5, ST5-8*** communicate and share solutions
* analyse data to inform decisions and draw conclusions, using a range of evaluation techniques.
 | **Teacher**Guide discussion and help students summarise relevant findings.**Students**Present the findings of their investigations to share data obtained and discuss the implications this may have on prototype designs.Analyse and evaluate findings shared from other groups which may be beneficial to design.Provide positive and constructive feedback to other groups. | Students demonstrate capacity to provide positive and constructive feedback to their peers. | Model the feedback process for students and provide a scaffold for feedback responses.Create a socially supportive classroom environment with a culture of positive feedback, encouragement and mutual support. |
| **Build final design****ST5-1, ST5-3, ST5-4, ST5-6**Students:* develop and evaluate creative, innovative and enterprising design ideas and solutions to a range of problems
* iterate designs
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Provide guidance to groups on managing tasks.Facilitate the use of tools and equipment by the students while providing active supervision.**Students**Review and discuss findings within groups and decide what further modifications may need to be made.Present an update of design/changes to the teacher.Perform necessary modifications to designed parts, assemble hardware components and build final design. | Students demonstrate practical skills, safely using appropriate tools, equipment, and techniques, to produce final design.Students demonstrate capacity to evaluate and modify designs. | (Add adjustments and registration) |
| **Evaluate final design****ST5-3, ST5-4, ST5-5, ST5-9**Students:* utilise components of a design process
* evaluate solutions
* collect and organise data in a range of formats
* analyse data to inform decisions and draw conclusions, using a range of evaluation techniques
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Outline Product Qualification as a process to determine whether a product design is fit for purpose (specified operating and environmental conditions).**Teacher and students**Review the requirement of increasing physical accessibility and/or providing an inclusive, mobile, remote presence for identified users by connecting them to learning and activities in classrooms.**Students**Test the continued operation of the robot under normal (or expected) operating conditions.Iterate through relevant tests used on prototype designs.Collect and organise data to compare with test data from earlier prototype designs.Critically reflect and evaluate performance of the final design solution against the success criteria.Demonstrate compliance with the identified requirements and success criteria.**Teacher and students**Evaluate the benefits of using information communication technologies to solve problems of physical accessibility. | Students demonstrate capacity to evaluate designs. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**Monitor the progress of student reflections.**Students**Complete weekly reflection identifying and evaluating new knowledge, understanding or skills in relation to previous knowledge. | Students answer reflective questions, for example:* What did I learn about this week?

Students will demonstrate the impact of these learning events or activities by making judgments about what has happened and what they still need to understand. | A procedural recount can be prepared on paper or digitally, including speech-to-text or voice recording.Modelling of the reflective process may assist with the metacognitive aspects of this task. |

**Note:** Option B is written as a structured inquiry learning experience using robots to assess the accessibility of existing passageways (thoroughfares) and ramps when travelling to a range of rooms, identify potential barriers of physical accessibility and propose solutions. The focus of this option is on the accessibility of pathways to rooms.

Additionally, this option could include designing a new ramp to increase physical accessibility to a school building.

Table 5 – project-based learning: Will any robot do? Weeks 5 to 8 learning sequence (option B)

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Option B – reviewing physical accessibility****ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-9**Students:* utilise components of a design process
* define problems or needs to gain understanding of requirements
* identify constraints and outline the scope for which the project will be confined.
 | **Teacher**Review challenge to design and conduct investigations to review and report on physical accessibility to a range of school rooms.Review sources of information, and results from mathematics and modelling activities (CAD or photogrammetry).Present existing use cases and examples of ramps.Explain social and practical difficulties encountered by people with mobility challenges, and the implications for design of access ramps.**Students**Summarise presented information using a graphic organiser. | Students can articulate the intent of using robots to test accessibility for people with restricted mobility.Students can describe the design challenge and link previous activities to this context. | (Add adjustments and registration) |
| **Define****ST5-2, ST5-3, ST5-4, ST5-5, ST5-7**Students:* utilise components of a design process
* define problems or needs to gain understanding of requirements
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher and students**Analyse the challenge and identify the group of people and their needs who would benefit from using access ramps.Discuss how to fairly assess whether a pathway to a room is accessible.Consider relevant questions from the [engineering design process teacher guide [DOC 1.09 MB]](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-engineering-design-process.docx).**Students**Review brainstorming mind map of initial thoughts and additional questions.Write a clear statement describing the problem to be solved.**Teacher and students**Define success criteria for the project. These may include:* complies with safety standards
* meets the needs of the user.

**Extension (optional)**If proposing a design for installation of a ramp, write a clear and concise design brief statement. | Students have created a mind map representing their thinking processes, including their understanding of:* the problem to be solved
* additional questions to be answered.

Students have refined the design brief into a concise statement.Students can express their understanding of the success criteria. | (Add adjustments and registration) |
| **Identify****ST5-3, ST5-4, ST5-5**Students:* identify constraints and outline the scope for which the project will be confined
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Define relevant terms, for example:* aesthetic
* functional
* ergonomic
* constraint.

Confirm start and finish dates, including delivery of presentation and supporting documentation for the review.**Students**Outline requirements of the end user and set thresholds for determining accessible/not accessible.Identify data and information that needs to be collected, for example:* pathways to rooms
* school buildings with stairways
* elevators
* existing ramps
* rooms with no ramp access.

Clearly identify relevant constraints impacting accessibility to rooms.**Extension (optional)**If proposing a design for installation of a ramp identify milestones for prototype development and testing including planned dates for key stages of the project. Document and present as a Gantt chart. | Students can clearly identify relevant constraints.Students have accurately collected measurements of components and produced a list of required dimensions.Students have used this information to inform their decision making and recorded any design thinking processes. This might also include additional annotations on sketches. | (Add adjustments and registration) |
| **Brainstorm****ST5-3, ST5-4**Students:* brainstorm and generate ideas
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Review divergent thinking.Outline some rules to guide and promote good brainstorming practise.**Students**Use divergent thinking to produce as many creative ideas for testing accessibility as possible.Produce thumbnail sketches and annotated drawings of initial ideas.**Teacher and students**Check for connections and relationships between generated ideas and merge where appropriate.Explore existing access ramp solutions to create new design ideas.**Students**Communicate and share ideas with class.**Extension (optional)**For rooms without accessible pathways:* use divergent thinking to generate designs for installation of a ramp
* produce thumbnail sketches and annotated drawings of initial ideas for ramps.
 | Students have produced a range of annotated sketches of possible designs.Students actively participate in class discussion and sharing of ideas. | (Add adjustments and registration) |
| **Design tests****ST5-1, ST5-2, ST5-3, ST5-4**Students:* design solutions, synthesise ideas and plan
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Explain the relevance and need to determine the:* maximum range of the robot
* maximum incline the robot can travel up
* Does the robot have sufficient power and locomotion?
* Will the robot’s changing centre of gravity cause it to topple over?
* Does the ramp surface provide enough friction?

**Students**Design processes based on the school’s unique physical environment and other constraints to simulate the robot travelling required distances and negotiating slopes or ramps, for example:* maximum range of the robot
* maximum incline
* consider if the robot has sufficient power and locomotion
* consider if the robot’s locomotion has sufficient traction
* the ramp surface provides enough grip (friction)
* consider the robot’s centre of gravity to prevent it from toppling over.

**Extension (optional)**For rooms without accessible pathways:* use convergent thinking to develop ideas and refine solutions.
* produce sketches, detail drawings, digital graphics to communicate solutions.
 | Students can design a viable firsthand investigation with accurate independent, dependent and controlled variables. | Provide template to scaffold student progress through investigation. |
| **Prototype (optional)****ST5-3, ST5-4, ST5-5, ST5-8**Students:* prototype design solutions.
 | **Extension (optional)**If proposing a design for installation of a ramp, use appropriate tools and materials to produce models or prototypes of the ramp design. | Students will have produced either scaled models or full-sized prototypes of a proposed ramp. | (Add adjustments and registration) |
| **Evaluate****ST5-3, ST5-4, ST5-5, ST5-9**Students:* prototype design solutions
* evaluate solutions
* iterate designs
* collect and organise data in a range of formats
* analyse data to inform decisions and draw conclusions, using a range of evaluation techniques
* work individually or collaboratively to apply an engineering design process to complete a practical, real-world project-based learning task.
 | **Teacher**Provide guidance, strategies or examples of procedures to test various criteria to initiate student investigations.**Students**Plan and conduct (an) independent investigation(s) to determine limitations of the robot and/or accessibility barriers to a range of classrooms, for example:* the maximum incline the robot can travel up a ramp.

Develop and refine strategies and procedures to test the robot and/or ramp.Collect, organise, and interpret data to inform and evaluate decisions.Critically reflect and evaluate the results against the success criteria.**Extension (optional)**If proposing a design for installation of a ramp:* Determine if prototype complies with building standards.

Plan and conduct (an) independent investigation(s) to determine if the robot can traverse a physical prototype of the ramp design using the same testing regime as above. | Students demonstrate practical skills, safely using appropriate tools, equipment, and scientific methods to undertake firsthand investigation.Students demonstrate the design of a test and evaluate the procedure and results to determine if the test needs to be repeated and/or modified to obtain meaningful results.Students demonstrate capacity to accurately assess data to draw conclusions or produce further questions.Students can evaluate the operation and performance of the robot using the success criteria under normal (or expected) operating conditions. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**Monitor the progress of student reflections.**Students**Complete weekly reflection, identifying and evaluating new knowledge, understanding or skills in relation to previous knowledge. | Students answer reflective questions, for example:* What did I learn about this week?

Students will demonstrate the impact of these learning events or activities by making judgments about what has happened and what they still need to understand. | A procedural recount can be prepared on paper or digitally, including speech-to-text or voice recording.Modelling of the reflective process may assist with the metacognitive aspects of this task. |

### Weeks 9 and 10

Table 6 – project-based learning: Will any robot do? Weeks 9 and 10 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 9 – innovation****ST5-2, ST5-5, ST5-10**Students:* investigate organisations who produce innovative solutions and evaluate their processes.
 | **Teacher**Outline [historical overview](https://ro.uow.edu.au/commpapers/787/) of how ideas become innovations.Present [introduction to innovation (4:17)](https://www.youtube.com/watch?v=rLA-vVLNvws).**Students**Recognise different forms of innovation presented.**Teacher**Outline stages of the innovation process:* ideation
* development
* commercialisation.

**Teacher and students**Identify and distinguish between ideation, development and commercialisation stages of the innovation process.Investigate organisations who produce innovative solutions and evaluate their processes, for example:* [how Apple is organised for innovation (4:35)](https://www.youtube.com/watch?v=5hENFA3CJUY)
* [Why is SpaceX so innovative? (6:20)](https://www.youtube.com/watch?v=pvIixu4iies)
* [How do you bring innovation to work? (3:47)](https://www.youtube.com/watch?v=sF6_deFmjmY).

**Students**Identify effective innovation processes, for example:* diverse people, ideas, and background knowledge
* building trust and being honest
* allowing a culture of risk taking
* idea-generation and evaluation techniques.
 | Students can describe effective innovation mindsets and processes.Students can provide insights into the habits of successful innovators. | Use closed captions when viewing video to assist understanding and vocabulary building. Pause or replay video to identify different entrepreneurial mindsets and skills. |
| **Entrepreneurial mindsets****ST5-2, ST5-5, ST5-10**Students:* investigate organisations who produce innovative solutions and evaluate their processes
* investigate and evaluate entrepreneurial mindsets and processes.
 | **Teacher**Outline the principles of entrepreneurship.Define key [entrepreneurial skills (4:48)](https://www.youtube.com/watch?v=2Vhcjg74PnA).Compare different types of problem solving, for example:* scientific reasoning
* mathematical reasoning
* action-oriented thinking.

Review the *define* phase of the [engineering design process teacher guide [DOC 1.09 MB]](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-engineering-design-process.docx) and compare it with steps to define authentic problems in entrepreneurial thinking, for example:* What is the problem?
* Whose problem is it?
* Why is it a problem?

**Students**Review the original design challenge and answer the 3 questions above.Explain links between the *define* phase and entrepreneurial thinking.Explain connections between all phases of the engineering design process and entrepreneurial thinking. | Students are able to demonstrate approaches and methods for understanding and categorising complex problems.Students can use techniques for structuring and solving problems. | (Add adjustments and registration) |
| **Commercialisation****ST5-2, ST5-5, ST5-10**Students:* identify the types of STEM professions that would be required for the commercialisation of a design solution
 | **Teacher**Define relevant terms, for example:* commercialisation
* intellectual property.

Outline stages of a [commercialisation process](https://techtransfer.org.au/ipc-training/commercialisation/the-early-commercialisation-process/).**Teacher and students**Identify the types of STEM professions that would be required for commercialisation of a design solution.**Teacher**Present [commercialisation manager (6:59)](https://www.youtube.com/watch?v=HaBUFIv8ufY).**Teacher and students**Identify aspects of the role and the range of skills that are beneficial to this job.Access [the marriage between commercialisation and academic research (3:01)](https://www.youtube.com/watch?v=JloLdkg-hVI).Discuss the value of commercialisation to academic research. | Students can recall what commercialisation is and the importance of protecting intellectual property.Students can explain the importance of a diverse skillset for industry professionals when transforming a design solution into a product (or service) ready for market. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**Monitor the progress of student knowledge and skills from reflections.**Students**Complete weekly reflection, identifying tasks undertaken, new knowledge, understanding or skills. | Students answer reflective questions, for example:* What did I learn about this week?
 | A procedural recount can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 10 – prepare****ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-8, ST5-9**Students:* document design processes using engineering reports or design portfolio
* investigate information communication technologies, tools, materials, and processes to produce a solution to an identified problem.
 | **Teacher**Facilitate fabrication of remaining final designs.**Students**Prepare report confirming requirements and/or deliverables have been achieved, for example:* hardware and software components, and subsystems are operational
* (additional) payload operational
* successful product qualification
* safety system processes compliant and operational.

Check all relevant aspects of the engineering design process are documented. | Students have produced an engineering report with a final evaluation, including data analysis, comparison between design drawings and final prototype, and suggested improvements. | (Add adjustments and registration) |
| **Communicate (allow minimum 2 days and/or related careers/guest speaker)****ST5-2, ST5-3, ST5-4, ST5-6, ST5-8**Students:* communicate and share solutions
* demonstrate ability to communicate design ideas using a range of drawing techniques as described in the STEM fundamentals core topic
* apply communication skills to pitch solutions to a range of different audiences
* communicate solutions to problems through information communication technologies.
 | **Teacher**Organise students to present their solutions to challenges assigned earlier in the unit, for example:* DIY telepresence robot
* results of product qualification
* robot modifications
* proposal for ramp installation
* ramp design
* human-centred design analysis.

**Students**Present solutions (and report) to assigned tasks or challenges.Listen respectfully to other presentations.**Extension (optional)**Invite relevant professionals or members of the school community to be part of the audience, for example:* school executive
* building inspectors
* council officers.
 | For a finished design solution or engineering report:* Students will be able to communicate how their design solution addresses the identified needs of the identified users.
* Students present a concise, factual report and/or demonstration that communicates their design solution properties and effectiveness.

For a proposed design solution:* Students produce a persuasive pitch directed towards a target audience that demonstrates the suitability of their solution.
* Students can articulate the role of a pitch to communicate a design solution.

Students demonstrate critical thinking, creativity, problem-solving, entrepreneurship, and engineering design skills in presenting their prototypes and designs. | Presentation format and medium may include:* speech
* poster presentation
* folio
* how-to tutorial
* recorded video and/or animation.
 |
| **Weekly reflection** | **Teacher**Assess the progress of student reflections.**Students**Complete weekly reflection identifying and evaluating new knowledge, understanding or skills in relation to previous knowledge. | Students answer reflective questions, for example:* What did I learn about this week?

Students will demonstrate the impact of these learning events or activities by making judgments about what has happened and what they still need to understand. | A procedural recount can be prepared on paper or digitally, including speech-to-text or voice recording.Modelling of the reflective process may assist with the metacognitive aspects of this task. |

## 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), [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/primary-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/primary-school/teaching-strategies/differentiation).
* **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](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher) 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, Multicultural Education.

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

**Creation date**: 15th 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).

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