# iSTEM – Design for space: ProtoSat



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## Design for space: ProtoSat

Students develop knowledge and an understanding of the role of CubeSats in space science, and the benefits of space science research for society. Working in groups, students follow an engineering design process to design, make, and evaluate a 1U CubeSat to collect weather data, and undertake ground testing using industry-inspired processes.

Students build on their knowledge and skills of coding using a general-purpose programming language to construct and code a FlatSat (CubeSat component ground testing device), designed to measure temperature, humidity, and air pressure. Students use the data collected to compare with other published sources of weather data and deduce possible causes for any differences.

Students use computer-aided design (CAD) software to design a case for their prototype CubeSat which houses the microcontroller and power supply and complies with the requirements definition. Students use cardboard prototyping and available fabrication techniques, which may include advanced manufacturing processes such as laser cutting or 3D printing (in addition to manual fabrication techniques) to develop prototypes based on their CAD designs and the requirements definition.

Students research, plan, and investigate the durability of at least one aspect of their CubeSat design and evaluate the results to make any necessary modifications. Students deploy the final design of their ProtoSat to collect weather data for a location within the school for a period of 2 weeks.

Students retrieve their ProtoSat to download the collected data and develop their skills in working with data by analysing aggregated datasets and creating visualisations.

### Duration of learning

Indicative time – 25 hours.

### Inquiry question

How do we ensure our satellites work before deploying them on missions into orbit or beyond?

### 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 sequencing 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 for 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) in this document.

### Weeks 1 and 2

Table – Design for space: ProtoSat weeks 1 and 2 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 1 – Space science**  **ST5-5, ST5-10**  Students:   * outline Australian and international historical perspectives in space and their impact on society * discuss the impact of advances in science and technology related to space exploration * outline the types of technologies used to travel beyond Earth’s atmosphere * investigate technologies used for space operations * describe the characteristics and uses for satellite technologies, and investigate the impact of satellite lifespan. | **Teacher**  Identify the current options available for making observations and/or conducting experiments in space, including:   * [International Space Station](https://www.nasa.gov/mission_pages/station/main/index.html) **(ISS)** * [satellites (1:54)](https://www.youtube.com/watch?v=cu4ZvCguhaw) * [sounding rockets (4:16)](https://www.youtube.com/watch?v=KyfQish8yqA) * [high-altitude balloons](https://rsaa.anu.edu.au/study/potential-projects/high-altitude-balloon-experiment-platform) **(HAB).**   **Introduce** [CubeSats (3:24)](https://www.youtube.com/watch?v=Z9iAMhaSiE4) **and their role in space research and** [filling a need (1:32)](https://www.youtube.com/watch?v=tNHpcZ6Ge_4) **in the development of the space industry in Australia.**  **Outline benefits of using CubeSats over larger traditional satellites.**  **Describe examples of current research involving the use of CubeSats, including:**   * [space weather (15:15)](https://www.youtube.com/watch?v=-BGXRGoEnAc) * [terrestrial weather (7:58)](https://www.youtube.com/watch?v=nG9lYpWy6KM) * [fresh water reservoirs](https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017WR022240) * [agriculture](https://www.abc.net.au/news/rural/2019-10-30/farmers-look-to-the-stars-for-crop-monitoring/11648496) **–** [crops](https://www.feedstuffs.com/news/cubesat-satellite-data-make-daily-crop-monitoring-possible) * **polar ice caps.**   **Introduce context-relevant terminology.**  **Explain the** [risks of launching satellites into space](https://www.captechu.edu/blog/hazards-of-space-how-satellite-missions-can-go-wrong)**, both during and after launch.**  **Students (optional)**  Explore the impact of satellites on communication systems, weather forecasting, and monitoring terrestrial events to improve decision-making. | Students can describe the role of CubeSats within the broader space research domain.  Students can explain the importance of accurate weather forecasting for society.  Students can explain the impact of satellites on weather forecasting.  Students can provide reasons for collecting weather data and predicting forecasts.  Using case studies on the applications of satellites, students demonstrate understanding and insight into awareness of potentially critical events and improve decision making in responding to current issues and finding solutions to problems. | (Add planned adjustments and enhancements, and registration. Ideas for appropriate adjustments and enhancements have been included).  Pre-teach key vocabulary and concepts prior to viewing videos, provide a transcript, and use closed captions when viewing.  Provide a glossary and allow the use of bilingual dictionaries for uncommon terms. |
| **ST5-5, ST5-10**  Students:   * investigate technologies used for space operations * investigate the nature of work undertaken in the space industry. | **Teacher**  Outline the intended outcomes of the project and explain what the students will be trying to create.  Outline essential stages of project management required to plan any space launch, including:   * requirements/deliverables definition/contract (what) * conceptual planning (how) * Preliminary Design Review (customer) * design/prototyping/component selection * Critical Design Review (customer) * purchase items/manufacture components/acceptance * Component and Subsystem Level tests * Integrated System tests * Environmental Qualification Campaign, ‘Shake n Bake’ (thermal cycling (ambient), thermal vacuum, shock, vibration) * Flight Acceptance Review (customer) * Launch! * Operations.   Outline the range of STEM careers in both the roles/jobs associated with the list above and the space industry in general.  Introduce more terminology relevant to project planning in aerospace, for example:   * launch commit criteria * mass budget. | Students can describe, verbally or in writing, what physical items they will be making and the documentation that will be required. At this early stage it would be sufficient for students to know they are making a functional model of a CubeSat (called the ProtoSat) which can measure and collect some basic weather data.  Students will be able to recall (with prompts if necessary) the sequence of essential stages for a space launch of a CubeSat.  Students will be able to outline some of the many STEM career pathways associated with the space industry. | Provide a glossary and allow the use of bilingual dictionaries for uncommon terms.  Provide visual and/or multimedia examples and check understanding of concepts.  Ensure all students understand both technical and culturally based terms.  Message abundancy may be useful when introducing new terminology. The word is spoken, written on the board, represented by visuals.  Provide a visual outline of essential stages of planning required for a space launch of a CubeSat. |
| **Team organisation**  **ST5-4, ST5-7**  Students:   * use project management techniques to plan solutions related to space * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Teacher**  Define specific roles available for students to undertake.  **Students**  Begin organising the team, assign roles where individual students have the opportunity to lead an aspect of the project, for example:   * software engineering lead * CAD design lead * experimental design lead * setup folio and record relevant information.   Setup shared folders for collaboration.  Examine the weather requirements as part of Launch Vehicle (LV) launch commit criteria.  **Extension (optional)**  Students [design a unique mission patch [PDF 195.66 KB]](http://www.spacecenter.org/docs/Activities-MissionPatch.pdf) for their group. | Students will have started their individual folio (paper or digital document) and recorded initial progress, relevant decisions and actions, and a plan of tasks to complete. Recording of activities and observations will be ongoing throughout the unit.  Students will understand how to access and contribute to the collaboration space.  Students will be able to explain how (and why) weather is an important requirement of the launch commit criteria. | Provide options for students to share roles if necessary.  Use visuals to outline lead role requirements.  A student folio can be prepared on paper or digitally, including speech-to-text or voice recording.  Model and scaffold to support students’ understanding of purpose, audience, language features, and structure.  Some students may need support to work in a group. |
| **Define deliverables**  **ST5-7**  Students:   * use project management techniques to plan solutions related to space. | **Teacher**  Define deliverables (requirements) of the ProtoSat project, for example:   * operating temperatures * ability to withstand environmental conditions * payload is no more than 100 g. | [insert evidence of learning] | Provide project template of deliverables. |
| **Weather data sources**  **ST5-2, ST5-4, ST5-5, ST5-9**  Students:   * collect, record, and analyse accurate, repeated measurements in the process of testing models, prototypes, and experiments * apply fundamental mathematical and statistical techniques related to space. | **Teacher**  List sources of weather data and classify them as either predicted or actual.  Define weather elements that will be captured in terms of data items.  Demonstrate how to use a spreadsheet program.  **Students**  Examine different sources of weather data, including:   * [Bureau of Meteorology](http://www.bom.gov.au/) (BOM) * thermometers * weather apps * apps on phones * digital sensors attached to microcontrollers or mini-computers.   Create a (shared) spreadsheet for collation and manipulation of defined data.  Take weather measurements, and record and compare with BOMpublished data. | Students can produce a spreadsheet for the collation and manipulation of data.  Students can assess the validity of data and subsequently recognise trends. | 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. |
| **Introduce microcontroller**  **ST5-4, ST5-5, ST5-6, ST5-8**  Students:   * program robotics technologies and physical computing platforms to create solutions * use a range of technologies for the purposes of producing space related prototypes, models,or experiments. | **Teacher**  Introduce microcontroller and other hardware to be used and explain safety issues.  Explain programming concepts, including:   * control structures * sequence * selection (branching) * repetition (iteration) * relevant data types * text * numbers * Boolean * functions (as necessary).   Demonstrate how the coding environment operates and how to upload code to the microcontroller.  **Students**  Learn to use selected coding environment to program microcontroller to perform some tasks which may include:   * blinking LEDs * reading sensor values. | Students can identify key hardware elements.  Students can articulate safety requirements of each piece of technology to be used.  Students can identify key features of a program written in the selected general-purpose coding language.  Students can enter instructions or code into the coding environment and successfully upload it onto the microcontroller.  Students can demonstrate success with properly functioning code as intended by the set task.  Students can identify errors in code operation and will be demonstrating computational thinking through the process of correcting code, for example:   * debugging syntax errors when code is not functioning properly * correcting logic errors if the code is functioning, but not as intended by the task. | 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 and revision.  Provide written and/or visual scaffold for identification of key elements and any safety requirements. |
| **Weekly reflections** | **Teacher**  Explain purpose of a weekly reflection.  Demonstrate how to complete a weekly reflection using a procedural recount.  **Students**  Complete weekly reflections using a school-basedtemplate or learning platform. | Students will be able to record their key learning events or activities using a procedural recount.  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. | Reflections can be prepared on paper or digitally, including speech-to-text or voice recording.  Model and scaffold to support EAL/D students’ understanding of purpose, audience, language features, and structure. |
| **Week 2 – FlatSat**  **ST5-4, ST5-5, ST5-6, ST5-8**  Students:   * program robotics technologies and physical computing platforms to create solutions * use a range of technologies for the purposes of producing space related prototypes, models or experiments * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Teacher**  Demonstrate a pre-assembled temperature sensor FlatSat ([CubeSat 101: Basic Concepts and Processes for First-Time CubeSat Developers](https://www.nasa.gov/content/cubesat-launch-initiative-resources), page 23) and explain its functions.  Show how to access and view the captured data.  **Students**  Build the FlatSat with temperature sensor according to instructions or specifications and test its operation. Modify as necessary to achieve a functioning unit.  Copy and upload provided sample temperature code onto microcontroller or create and upload original code using a general-purpose coding language. Test and modify as necessary.  Collect data from the Bureau of Meteorology (BOM website or app) and compare it to data from the FlatSat, suggest reasons for any discrepancies.  Evaluate functions. | Students produce a functioning temperature sensing FlatSat comprising:   * microcontroller (for example, Raspberry Pi Pico, Arduino Uno or Micro:bit) * power-timer modules or real time clock (RTC) * temperature sensor * battery pack/power supply.   Students can demonstrate how the unit operates and how to view and collect the data.  Students can troubleshoot code and resolve syntax errors. | During practical learning activities, use and emphasise target language required and encourage students to use this language in context. |
| **ST5-4, ST5-5, ST5-6, ST5-9**  Students:   * program robotics technologies and physical computing platforms to create solutions * use a range of technologies for the purposes of producing space related prototypes, models or experiments * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Teacher**  Outline the extra functionality required, including:   * humidity * pressure * altitude (calculated from temperature and pressure) * UV exposure (optional).   Outline the conditions the FlatSat and student CubeSat unit will operate under and guide students in developing an algorithm to measure, calculate and record the weather elements listed above. This will also include the rate of measurements (for example measurements per hour and length of time record data), the required precision, and the formatting of the collected data.  **Students**  Develop an algorithm for the ongoing operation of the FlatSat as defined by the class.  Translate the algorithm into a general-purpose coding language. Upload and test for syntax and logical errors.  Evaluate function (ongoing) and record details in student folio. | Students produce and test an algorithm to measure and record temperature, humidity, and pressure.  Students will have assessed the operation of the unit and recorded any changes in their design folio. | Provide a glossary and allow the use of bilingual dictionaries for uncommon terms. |
| **ST5-4, ST5-5, ST5-6, ST5-9**  Students:   * collect, record, and analyse accurate, repeated measurements in the process of testing models, prototypes and experiments * program robotics technologies and physical computing platforms to create solutions * use a range of technologies for the purposes of producing space related prototypes, models or experiments * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Students**  Continue writing code and testing for reliable data capture.  Evaluate function (ongoing) and record details in student folio.  Collect data from the Bureau of Meteorology (BOM) website or app (or similar source) and compare it to data from the FlatSat (sensor rig).  Analyse and provide reasons for any discrepancies. | Students will have produced code and performed troubleshooting in a general-purpose coding language.  Students will be able to describe what parts are working properly and what parts need further improvement. Students should be articulating how they know whether their code is working properly or not.  Student folios should clearly display some observations of feedback from the coding environment and whether/how they responded to address any identified issues.  Students should be able to identify any notable differences in data between the 2 sources and propose the cause(s). | Provide scaffolds for student responses and/or folio entries. |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **Students**  Complete weekly reflections using a school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount.  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. | Reflections can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 3 and 4

Table – Design for space: ProtoSat weeks 3 and 4 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 3 – Location, location**  **ST5-4, ST5-5, ST5-6, ST5-9**  Students:   * collect, record and analyse accurate, repeated measurements in the process of testing models, prototypes and experiments * program robotics technologies and physical computing platforms to create solutions * use a range of technologies for the purposes of producing space related prototypes, models or experiments * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Teacher**  Lead class discussion on where weather data is collected around the school. Apart from issues like Work Health and Safety (WHS), exposure to the elements, and the security of the devices, the criteria may focus on selecting various conditions to obtain an interesting range of data.  Establish a FlatSat within the classroom/staffroom to operate from the beginning of week 3 to the end of the unit, to provide baseline data for class.  **(Note: This FlatSat could be connected to a computer for regular access to data by students).**  **Students**  Identify test locations around the school and evaluate suitability.  Continue collecting and recording data from the BOM source and compare it to the data from FlatSat (and eventually student CubeSats). Collate and store data during the unit for use in later exercises and the folio.  Using the data collected over a longer time period, analyse and suggest reasons for any discrepancies. | Students can justify/provide reasons for selected locations based on agreed criteria.  Students collate and compare weather data from different sources, checking for FlatSat system error. | (Add adjustments and registration) |
| **CubeSat specifications**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-10**  Students:   * outline the types of technologies used to travel beyond Earth’s atmosphere * investigate technologies used for space operations * discuss the impact of advances in science and technology related to space exploration * apply fundamental mathematical and statistical techniques related to space. | **Teacher**  Present the [official CubeSat specifications [PDF 3.46 MB]](https://static1.squarespace.com/static/5418c831e4b0fa4ecac1bacd/t/62193b7fc9e72e0053f00910/1645820809779/CDS+REV14_1+2022-02-09.pdf) and reference websites for students to begin researching 1U CubeSats.  Alternatively, outline any modifications to dimensions, payload constraints, and construction materials or establish the modified criteria with the class.  **Students**  Research external and internal dimensions for CubeSats and construction materials.  Identify and assess known relevant constraints, which may include:   * construction materials * power requirements/power sources * heat dissipation * mass.   Measure dimensions of internal hardware components, including mass.  Generate a design solution for how FlatSat components can be reconfigured to fit within predefined dimensions.  **Extension (optional)**  Students measure heat dissipation and/or derive methods of determining heat dissipation and explore cooling strategies. | [insert evidence of learning] | (Add adjustments and registration) |
| **Cardboard prototype**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-8**  Students:   * demonstrate practical skills, safely using appropriate tools, equipment and techniquesto produce models, prototypes, or experiments. | **Teacher**  Check that students understand the required criteria, project deliverables, and timelines.  **Students**  Apply the design process to develop a cardboard prototype CubeSat casing for housing the hardware components, including:   * microcontroller * sensor(s) * power timer module or RTC * power source.   Test fit componentsto demonstrate success. | Students produce a cardboard development prototype to test fit internal hardware components.  Students demonstrate and record an iterative prototyping process until a workable design is achieved. | (Add adjustments and registration) |
| **Weekly reflection** | **Students**  Complete weeklyreflections using a school-based template or learning platform. | Students demonstrate critical thinking skills in using procedural recount in the production of a weekly reflection document. | Reflections can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 4 – Introduce CAD**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-8**  Students:   * demonstrate practical skills, safely using appropriate tools, equipment, and techniques to produce models, prototypes, or experiments * investigate the nature of work undertaken in the space industry. | **Teacher**  Demonstrate how to use suitable CAD software and save a variety of formats for any of the following purposes:   * printing * [3D printing](https://asc-csa.gc.ca/eng/search/images/watch.asp?id=10185&search=cubesat) (STL files) * laser cutting * reference images for folio.   Demonstrate examples of [3D printed CubeSat frames](https://www.thingiverse.com/thing:27300), laser cut models, or cardboard prototypes.  **Students**  Begin to generate designs on CAD software.  Evaluate and modify as necessary. | [insert evidence of learning] | (Add adjustments and registration) |
| **CAD and fabrication**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-8**  Students:   * demonstrate practical skills, safely using appropriate tools, equipment and techniques to produce models, prototypes, or experiments. | **Teacher**  Organise and facilitate safe fabrication processes, which may include:   * cardboard prototyping * 3D printing * laser cutting.   **Students**  Continue with CAD design work.  Refine prototypes, considering flight-ready materials informed by design.  Evaluate and modify as necessary. | [insert evidence of learning] | (Add adjustments and registration) |
| **CAD and fabrication**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-8**  Students:   * demonstrate practical skills, safely using appropriate tools, equipment and techniques to produce models,prototypes, or experiments. | **Teacher**  Organise and facilitate safe fabrication processes, which may include:   * cardboard prototyping * 3D printing * laser cutting.   **Students**  Refine prototypes, considering mounting points for payload informed by design, and evaluate and modify as necessary. | [insert evidence of learning] | (Add adjustments and registration) |
| **Weekly reflection** | **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflections using a school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount.  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. | Reflections can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 5 and 6

**Note:** Depending on the students’ abilities and constraints like available time, a group might only perform one of the 4 tests listed. The results from other groups’ tests could be shared (see weeks 7 and 8) to allow for a more efficient use of time and provide the data to assist in making any necessary modifications.

Table – Design for space: ProtoSat weeks 5 and 6 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Environmental qualification**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-8, ST5-9**  Students:   * apply fundamental mathematical and statistical techniques related to space * demonstrate practical skills, safely using appropriate tools, equipment and techniques to produce models, prototypes, or experiments * collect, record and analyse accurate, repeated measurements in the process of testing models, prototypes and experiments * use project management techniques to plan solutions related to space * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems related to space. | **Teacher**  Outline the purpose of an Environmental Qualification Campaign and refer to the General Environmental Verification Standard ([GEVS](https://standards.nasa.gov/standard/gsfc/gsfc-std-7000)).  Describe the ‘Shake n Bake’ tests relevant to this project, for example:   * vibration * shock (or impact) * thermal cycling (ambient) * [thermal vacuum](https://lasp.colorado.edu/home/csswe/system/testing/thermal-vacuum/).   For [thermal cycling and thermal vacuum testing](https://spaceaustralia.com/news/unsw-canberra-space-gearing-launch-next-cubesat), describe the operation of the Wombat XL thermal vacuum testing structure at the [National Space Test Facility](https://inspace.anu.edu.au/nstf) (ANU).  Organise the class into suitable groups and provide guidance to groups on managing tasks. Supervise groups that may be planning and conducting investigations/experiments.  Facilitate the use of tools and equipment by the students while providing active supervision.  Advise student groups on planning and selecting tasks (project management).  **Note:** 3D printing and laser cutting previous week’s designs could still occur while students are researching for upcoming planned tests. | [insert evidence of learning] | Consideration for students who find working in groups challenging and/or undertaking a particular defined group role.  Provide opportunities to practise skills before working in a group (or options to work independently or in pairs). |
| **Environmental qualification (continued)**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-9**  Students:   * demonstrate practical skills, safely using appropriate tools, equipment and techniques to produce models, prototypes, or experiments * collect, record and analyse accurate, repeated measurements in the process of testing models, prototypes and experiments * use project management techniques to plan solutions related to space * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems related to space. | **Teacher**  Plan and conduct (an) independent investigation(s) to:   * determine a fair and reasonable testing regime able to demonstrate compliance with the specified requirements and deliverables * design and construct any required test apparatus * test the structural integrity of their CubeSat design, and/or test the continued operation of the CubeSat unit under normal (or expected) operating conditions. | [insert evidence of learning] | Provide visual and/or multimedia examples and check understanding of concepts prior to investigations.  Ensure all students understand both technical and culturally based terms. |
| **Vibration testing**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-9**  Students:   * demonstrate practical skills, safely using appropriate tools, equipment and techniques to produce models, prototypes, or experiments * collect, record and analyse accurate, repeated measurements in the process of testing models, prototypes and experiments * use project management techniques to plan solutions related to space * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems related to space. | **Teacher**  Provide examples of [vibration testing (1:03)](https://www.youtube.com/watch?v=y90V0o2_HHY) experiments, such as a [student made shake table [PDF 667.37KB]](https://www.questacon.edu.au/sites/default/files/resources/teacher-resources/file/Shake%20Table%20Lesson%20Plan.pdf), to initiate student research.  **Students**  Research CubeSat launches and identify a typical duration of launch to determine the duration of a vibration test.  Design investigation to test the CubeSat casings durability to withstand vibrations. | Students will have planned a safe vibration test of their prototype CubeSat.  Students will have safely performed the investigations and recorded findings.  Students can evaluate these findings and adjust their group’s design. | Provide visual and/or multimedia examples and check understanding of concepts and proposed procedures prior to investigations.  Ensure all students understand both technical and culturally based terms. |
| **Impact testing**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-9**  (All content points listed under vibration testing are relevant here.) | **Teacher**  Provide examples of [impact testing (0:43)](https://www.youtube.com/watch?v=SfGjNQZ78Eo) experiments to initiate student research.  **Students**  Research how the payload is securely attached in the casing and the velocity of CubeSats (and other launch vehicles) in launch and operation.  Design investigation to test the durability of component anchor points to the CubeSat to ensure the payload is not dislodged during operation. | Students will have planned an impact test of their prototype CubeSat.  Students will have safely performed investigations and recorded findings.  Students can evaluate these findings and adjust their group’s design. | Provide visual and/or multimedia examples and check understanding of concepts and proposed procedures prior to investigations.  Ensure all students understand both technical and culturally based terms. |
| **Thermal testing**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-9**  (All content points listed under vibration testing are relevant here). | **Teacher**  Provide examples of [thermal testing (operating temperatures) (0:37)](https://www.youtube.com/watch?v=aWNgM58kUas) experiments to initiate student research.  **Students**  Research the operating temperature conditions of CubeSats.  Design investigation to test the functionality of electronics under expected temperature conditions during the operations phase. | Students will have planned a safe temperature (thermal) test of their prototype CubeSat.  Students will have safely performed the investigation and recorded findings.  Students can evaluate these findings and adjust their group’s design. | Provide visual and/or multimedia examples and check understanding of concepts and proposed procedures prior to investigations.  Ensure all students understand both technical and culturally based terms. |
| **Material testing (optional)**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-9**  (All content points listed under vibration testing are relevant here). | **Students**  Research material testing, including extreme impact tests.  Design an investigation to test the CubeSat casings durability to withstand impact (either from space debris or return to earth in the event of launch failure). | Students plan a materials test relevant to the design of their prototype CubeSat.  Students safely perform investigations and record findings.  Students evaluate findings and adjust their group’s design. | (Add adjustments and registration). |
| **Low gravity (optional)**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-9**  (All content points listed under vibration testing are relevant here). | **Teacher**  Provide examples of low gravity experiments to initiate student research.  **Students**  Research the effects of low gravity in space environments to inform how hardware is mounted inside CubeSat. | Students plan a low gravity investigation relevant to the design of their prototype CubeSat.  Students safely perform investigations and record findings.  Students evaluate findings and adjust their group’s design. | (Add adjustments and registration). |
| **Power supply (optional)**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-7, ST5-9**  (All content points listed under vibration testing are relevant here.) | **Teacher**  Provide examples of power supply testing experiments to initiate student research.  **Students**  Map out a sequence of events for a CubeSat launch (or mission) and identify environmental conditions CubeSat is exposed to. This determines how long a power supply must last for a typical mission and under typical conditions. | Students identify relevant findings and record these.  Students adjust their group’s design. | (Add adjustments and registration). |
| **Weekly reflection** | **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflections using a school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount.  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. | Reflections can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 7 and 8

Table – Design for space: ProtoSat weeks 7 and 8 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 7 – Review findings**  **ST5-2, ST5-5, ST5-7, ST5-8**  Students:   * use project management techniques to plan solutions related to space * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems related to space. | **Students**  Present the findings of their investigations, carried out in weeks 5 and 6, to share data that were obtained and the implications this may have on their prototype design.  **Teacher**  Guides discussion and helps students summarise relevant findings. | Students will be able to present findings and articulate the impact of the results on the design of CubeSat. | Consider multiple modes of delivering presentation. |
| **ST5-1, ST5-2, ST5-3, ST5-4, ST5-6**  Students:   * design and build a system to solve real-world space related problems * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios * use project management techniques to plan solutions related to space * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems related to space. | **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. | Students record a review of findings and provide clear reasons why changes, if any, should be conducted. | (Add adjustments and registration) |
| **ST5-1, ST5-2, ST5-3, ST5-4, ST5-6**  Students:   * demonstrate practical skills, safely using appropriate tools, equipment and techniques to produce models, prototypes, or experiments * design and build a system to solve real-world space related problems * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Students**  Perform necessary modifications to casings and assemble hardware components and power supply. | [insert evidence of learning] | (Add adjustments and registration) |
| **Flight Acceptance Review report**  **ST5-4, ST5-6, ST5-7, ST5-8**  Students:   * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios * use project management techniques to plan solutions related to space * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems related to space. | **Students**  Prepare Flight Acceptance Review report for customer, confirming:   * requirements and deliverables have been achieved * component and subsystem are operational (coding and output) * Integrated System Tests (payload operational in CubeSat casing) * successful environmental qualification * vibration * impact * temperature. | Students will have produced the required documentation in a suitable format and with appropriate detail. | Provide a report template.  Model and scaffold to support students’ understanding of purpose, audience, language features, and structure. |
| **Weekly reflection** | **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflections using a school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount.  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. | Reflections can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 8 – Go/No go confirmation**  **Launch ready**  **ST5-4, ST5-6, ST5-7, ST5-8**  Students:   * program robotics technologies and physical computing platforms to create solutions * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios * use project management techniques to plan solutions related to space * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems related to space. | **Teacher**  Sign-off of Flight Acceptance Review and give ‘Go/No go’ status confirmation to launch crews.  **Students**  Deploy finished CubeSat to the identified location in the school. Initiate power and begin monitoring.  (If it appears the ProtoSat stops functioning, students retrieve the unit and determine likely causes of any failures). | Students diligently monitor the operation of the ProtoSat and confirm it is functioning through regular observations.  Students are able to deduce the cause(s) of malfunctions and provide reasons to justify their inference. | (Add adjustments and registration) |
| **Operations**  **ST5-4, ST5-5, ST5-10**  Students:   * investigate the nature of work undertaken in the space industry * investigate the pathways into space careers * engage in industry career development opportunities to gain a deeper knowledge of the space sector, develop skills, knowledge and understanding of authentic, real-world problem-solving. | **Teacher**  Outline some activities undertaken during operations.  **Student**  Monitor the operation of the deployed CubeSat and confirm continued functioning.  **Teacher and students**  Explore pathways for a career in space, for example:   * space scientist * space lawyer * cyber security specialist * Computer Numerical Control (CNC) machinist * avionics technicians * robotics engineers.   Discuss the need for multiple roles and careers in the space industry and the need for diversity in problem-solving teams. | [insert evidence of learning] | (Add adjustments and registration) |
| **History**  **ST5-10**  Students:   * outline Australian and international historical perspectives in space and their impact on society * discuss the impact of advances in science and technology related to space exploration * explain the effects of emerging space technologies. | **Student**  Monitor the operation of the deployed CubeSat and confirm continued functioning.  **Teacher and students**  Discuss the history and development of space exploration, especially issues such as manned versus unmanned space exploration, spacecraft design, launch and navigation, imaging, and remote sensing.  Evaluate the effects of these technologies used in space exploration.  Outline the role of Australian scientists in space missions, for example:   * tracking stations * moon rovers. | Students can recognise some social implications of space science. They can present arguments around the costs, risks and benefits of space exploration. | Include multiple opportunities to respond, for example:   * verbally * individually * partner turn and talk * non-verbally * gesture * response cards. |
| **Weekly reflection** | **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflections using a school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount.  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. | Reflections can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 9 and 10

Table – Design for space: ProtoSat weeks 9 and 10 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 9 – Impact**  **ST5-2, ST5-5, ST5-10**  Students:   * outline Australian and international historical perspectives in space and their impact on society * describe a range of everyday technologies that have emerged out of space research, and their impact on society * discuss the impact of advances in science and technology related to space exploration * critically evaluate issues related to space exploration. | **Students**  Monitor the operation of the deployed CubeSat and confirm continued functioning.  **Teacher and students**  Discuss the [impact of space junk [PDF 216.18KB]](https://orbitaldebris.jsc.nasa.gov/library/sciencemag-risks-in-space-from-orbiting.pdf) on operational satellites and missions.  **Students**  Research the [lifespan](https://www.euspaceimaging.com/the-lifespan-of-orbiting-satellites/) of a satellite.  **Extension (optional)**  Debate the value (or impact) of space exploration and research on society, for example:   * [scientific](https://www.nasa.gov/connect/ebooks/iss_benefits_for_humanity.html) * economic * [societal](https://www.nasa.gov/connect/ebooks/historical_studies_societal_impact_spaceflight_detail.html). | Students actively participate in classroom discussion.  Students produce a report on the life of the satellite.  Students can recognise some social implications of space science. They can present arguments around the costs, risks, and benefits of space exploration. | Include multiple opportunities to respond, for example:   * verbally * individually * partner turn and talk * non-verbally * gesture * response cards. |
| **Communication links**  Students:   * explain a range of scientific laws and theories related to space * create or simulate communication links between devices, for example: * remote sensors * wireless. | **Teacher**  Explain communications with satellites and space probes to transmit and receive data.  Present [satellite communication basics (6:03).](https://www.youtube.com/watch?v=nIQamhsCGeU)  Discuss the speed at which communication can occur and the impact of line of sight (LOS).  **Teacher and students**  Calculate the communication times with near earth satellites and distant space probes. Discuss the implications of this potential time lag.  Simulate a wireless link between devices.  **Extension (optional)**  Simulate the interference of a wireless link. | [insert evidence of learning] | (Add adjustments and registration) |
| **Visualising data**  **ST5-4, ST5-5, ST5-9**  Students:   * apply fundamental mathematical and statistical techniques related to space * collect, record, and analyse accurate, repeated measurements in the process of testing models, prototypes and experiments. | **Teacher**  Demonstrate how to collect and prepare data from the FlatSat.  Demonstrate how to use data to create visualisations.  (Provide a sample dataset if necessary to allow students to do the visualisation activity.)  **Students**  Collect and prepare data from the original FlatSat (or a sample dataset) and use computer software to create charts and simple visualisations. | Students can construct charts and simple visualisations from provided test data (in preparation for loading real data into charts). | (Add adjustments and registration) |
| **Weekly reflection** | **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflections using a school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount.  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. | Reflections can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 10 – Retrieval**  **ST5-4**  Students work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Teacher and students**  Retrieve CubeSats and download data to place in a shared drive. | [insert evidence of learning] | (Add adjustments and registration) |
| **Prepare data**  **ST5-4, ST5-5, ST5-9**  Students:   * apply fundamental mathematical and statistical techniques related to space * collect, record, and analyse accurate, repeated measurements in the process of testing models, prototypes and experiments * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Student**  Use spreadsheets or statistical software packages to tabulate and graph data from their CubeSat.  Graph more than one dataset on the same set of axes using a spreadsheet or graphing software and compare the graphs to determine similarities and differences.  Evaluate collected data according to agreed criteria. | [insert evidence of learning] | (Add adjustments and registration) |
| **Evaluate mission data**  **ST5-2, ST5-5, ST5-7, ST5-8, ST5-9**  Students:   * apply fundamental mathematical and statistical techniques related to space * collect, record and analyse accurate, repeated measurements in the process of testing models, prototypes and experiments * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Teacher and students**  Discuss the value of data.  Some questions to consider:   * Which data is more accurate, the ProtoSat or the BOM? * Which data is more reliable, the ProtoSat or the BOM? * What is the quality of this data? * What are the dimensions of this data? * How well does the information from this data reflect reality? * What is the value of weather data? * What are the implications of this captured data? | Students actively participate in classroom discussion. | Include multiple opportunities to respond, for example:   * verbally * individually * partner turn and talk * non-verbally * gesture * response cards. |
| **Weekly reflection** | **Teacher**  Assess the progress of student knowledge and skills from reflections.  **Student**  Complete weekly reflection evaluating new knowledge, understanding or skills in light of 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. | Reflections can 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#.Y9mUe70AtNc.link).

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](mailto: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, EAL/D.

**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).

## 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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