# iSTEM – Design for space: Critical problem-solving

**Combined Elective and Specialised Topic**



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## Design for space: Critical problem-solving

This learning sequence introduces students to the Critical Problem-Solving elective topic through the context of space exploration and research. Students will create a solution to an advanced design problem in space, then simulate an experiment similar to those on the International Space Station (ISS).

During weeks 1 to 8 of the learning sequence, students will apply critical problem-solving skills to develop a solution to a space-specific problem. They will design and conduct a scientific experiment related to space to obtain primary data. Students will learn to analyse and evaluate the results of the experiment through the development of a scientific report.

During weeks 9 to 20 of the learning sequence, students will design, construct, and test an environmental monitoring experiment to simulate a research mission on the ISS. The design solutions will include a functioning microcontroller-based prototype, programmed to monitor environmental factors with sensors and/or servo motors based on the specific solution chosen. Students will present their planned solution in the form of a design pitch in week 13 of the sequence.

This learning sequence combines the Design for Space specialised topic with the Critical Problem-Solving elective topic. The integrated approach provides a space-based contextual theme to explore critical problem-solving content. The learning sequence is structured to accommodate assessment and reporting periods for Semester 2 delivery.

### Duration of learning

Indicative time – 50 hours.

### 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. 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, 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: Critical problem-solving weeks 1 and 2 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 1 – Introduction**  **ST5-2**  Students:   * define critical thinking and complex problem-solving * identify common principles that hinder critical thinking. | **Teacher**  Introduce the learning sequence, including Design for space and Critical problem-solving topics.  Outline the structure and overview of themes contained within these topics.  Introduce critical thinking and complex problem-solving as a concept.  Compare [critical thinking](https://www.monash.edu/learnhq/enhance-your-thinking/critical-thinking/what-is-critical-thinking#:~:text=Critical%20thinking%20is%20a%20kind,hear%2C%20say%2C%20or%20write.&text=Good%20critical%20thinking%20is%20about,negative%20or%20focusing%20on%20faults.) and [complex problem-solving](https://www.indeed.com/career-advice/career-development/complex-problem-solving#:~:text=Complex%20problem%20solving%20is%20a,a%20solution%20to%20a%20problem.&text=Complex%20problem%20solving%20also%20involves%20considering%20the%20impact%20of%20the,the%20surrounding%20environment%20and%20individuals.) to the engineering design process and the scientific method.  Outline a range of common principles that hinder critical thinking.  **Students**  Describe real-world problems from a local, national, or international context and what constrains humans from solving these problems.  Review methodologies for solving problems, such as the iSTEM process and the scientific method. | Students can identify the role that critical thinking and problem-solving play in the application of the engineering design process and the scientific method.  Students can define critical thinking and complex problem-solving.  Students can identify principles that hinder critical thinking. | (Add adjustments and registration) |
| **ST5-5, ST5-10**  Students:   * critically evaluate issues related to space exploration. | **Teacher and students**  Brainstorm a range of factors that hinder space exploration and research, such as microgravity, sustainable food, water and oxygen sources, space junk, size and [mass of payloads [PDF 225KB]](https://www.nasa.gov/sites/default/files/atoms/files/geometry_of_circles-activity.pdf).  Debate the effects on the environment and economy of a space mission. Justify the costs compared to advancements in scientific understanding ([cost-benefit analysis](https://online.hbs.edu/blog/post/cost-benefit-analysis#:~:text=A%20cost%2Dbenefit%20analysis%20is,sense%20from%20a%20business%20perspective.)).  Discuss the physical, chemical, and biological constraints of space exploration as a class.  **Students**  Discuss, ‘Is the responsible and ethical exploration of outer space possible?’  Develop a list of 5 reasons why exploration of outer space is good for society and 5 reasons why it is bad for society. | Students can identify a range of positive and negative issues related to space exploration and research.  Students can justify scientific advancements against the impacts of space research.  Completed cost-benefit analysis. | (Add adjustments and registration) |
| **ST5-6**  Students:   * discuss the impact of advances in science and technology related to space exploration. | **Teacher**  Using a space-based scientific research technology, outline a space-related problem to be solved. For example:   * ExoLab * NASA Artemis program * NASA’s James Webb Space Telescope * NASA Analog missions * CubeSats and FlatSats * CubeLabs * Global Positioning Satellites (GPS) * Weather monitoring.   **Students**  Explain the impact of space research programs with reference to a specific scientific research technology. | Students develop a case study of the benefits of one specific advancement in space exploration technology. | (Add adjustments and registration). |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 2 – Space problem**  **ST5-1 ST5-2, ST5-3, ST5-4**  Students:   * investigate a range of problem-solving and decision-making strategies * develop and evaluate creative, innovative, and enterprising solutions to a range of complex problems * apply critical thinking methodologies. | **Teacher**  Introduce a sample design problem with a space context for students to complete in one week as a revision of skills developed in [iSTEM fundamentals](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4).  Example design problems could include:   * a [planetary exploration balloon](https://www.jpl.nasa.gov/edu/learn/project/make-a-planetary-exploration-balloon/) * [thermal coatings](https://www.nasa.gov/stem-ed-resources/nasa-stem-stars-thermal-coatings-engineer.html) * [LEGO missions](https://education.lego.com/en-us/build-to-launch) * [zero-gravity instruments [PDF 16.1MB]](https://www.unoosa.org/res/oosadoc/data/documents/2013/stspace/stspace63_0_html/st_space_63E.pdf).   Explain to students why it is important to use experimental design as a problem-solving strategy in the context of the Design for Space topic.  Introduce students to experimental design so that students can test the physical, chemical, or biological constraints of space, for example:   * gravitational biology * atmospheric friction * life support systems * habitat designs * radiation.   **Students**  Use appropriate brainstorming techniques to solve a problem and develop ideas for an experimental design to test physical, chemical, or biological constraints.  Apply the [iSTEM engineering design process [PDF 2.9MB]](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-engineering-design-process.pdf) to define the problem and identify constraints.  Sketch potential solutions and evaluate them based on the constraints.  Share design ideas with a peer for review. | Students understand the process of experimental design.  Students develop problem-solving and decision-making strategies as they progress through an engineering design process.  Students can apply critical thinking techniques by creating and evaluating an experiment or engineered solution to the impacts of space exploration.  Students apply critical thinking skills to the completion of a design process.  Students produce a range of sketches that communicate their potential design solution. They will present these sketches in a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645) activity for peer feedback. | Consider accessibility needs and alternative options when producing sketches. |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 3 and 4

Table – Design for space: Critical problem-solving weeks 3 and 4 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 3 – Space problem experiment**  **ST5-5, ST5-9**  Students:   * complete practical exercises solving space related problems * apply appropriate research models and methodologies to gather valid reliable data. | **Teacher**  Introduce the scientific method for conducting a space problem experiment, for example, a biodome.  Explain that the experiment must produce firsthand data by measuring the independent variable, and the experiment must be able to produce results within 3 weeks.  Outline variables that must be controlled in the experiment.  Identify the independent variable as the factor that is varied for experimentation.  Identify the dependant variable as the factor that is measured as a result of the independent variable.  List possible dependent variables to be measured, such as, CO2 levels, O2 levels, temperature, humidity, plant growth.  Outline scientific equipment to be used for the experiment.  **Students**  Discuss and use [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645) activities to develop ideas for the independent and dependent variables to be assessed, for example, light level, pH, salt content, light colour, temperature.  **Extension**  This experiment could be conducted using [ExoLab](https://magnitude.io/exolab-10/) or a student-built biodome. | Students formulate hypotheses around the impacts of space environments on their experiment.  Students can identify the dependent, independent, and controlled variable in an experiment.  Students can plan and run a valid, reliable, and accurate scientific experiment. | (Add adjustments and registration) |
| **ST5-9**  Students:   * apply appropriate research models and methodologies to gather valid, reliable data. | **Students**  Conduct research to decide on chosen variables.  Choose an independent variable to be tested and a dependant variable to be measured.  Develop an aim and hypothesis appropriate to the chosen experiment. | Students apply appropriate methodologies to gather data from an experiment.  Students can develop an appropriate aim and hypothesis. | (Add adjustments and registration) |
| **ST5-9**  Students:   * apply appropriate research models and methodologies to gather valid, reliable data. | **Students**  Conduct research to decide on chosen variables.  Choose an independent variable to be tested and a dependant variable to be measured.  Develop an aim and hypothesis appropriate to the chosen experiment. | Students apply appropriate methodologies to gather data from an experiment.  Students can develop an appropriate aim and hypothesis. | (Add adjustments and registration) |
| **Experiment Journal**  **ST5-9**  Students:   * collect, record, and analyse accurate, repeated measurements in the process of testing models, prototypes, and experiments. | **Teacher**  Explain the purpose of the experiment journal.  Demonstrate how to complete a weekly experiment journal and provide samples using data obtained from student experiments.  Explain that measurements and observations should be repeated for reliability and should be recorded in each lesson where appropriate.  **Student**  Measure data from their space problem experiment and record it in a table.  Make observations and record them in a journal, including descriptions, diagrams and/or photos of the experiment. | Students can collect and record accurate measurements in a table.  Students can record regular observations of an experiment.  Students produce spreadsheets to record data and produce visualisations. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 4 – Experimental setup**  **ST5-6**  Students:   * develop and evaluate creative, innovative, and enterprising solutions to problems * apply appropriate research models and methodologies to gather valid reliable data. | **Teacher**  Outline the requirements for an equipment list, method, and risk assessment, in alignment with the standards used in science at your school.  **Students**  Develop an inquiry question that will guide the experiment.  Develop an equipment list, method, and risk assessment for a chosen plant growth experiment. | Students apply knowledge of the scientific method with acquired knowledge about the challenges of space environments to formulate an inquiry question.  Students use scientific equipment to set up an experiment. | (Add adjustments and registration) |
| **ST5-5, ST5-6**  Students:   * develop and evaluate creative, innovative, and enterprising solutions to problems * apply appropriate research models and methodologies to gather valid reliable data. | **Teacher**  Provide students with the appropriate equipment for their chosen experiment.  Assist students to set up experiments.  Provide guidance to students about when and how the experiments will be conducted. For example, the ongoing collection of data, or results from repeated one-off tests.  **Students**  Set up their experiment, making sure all controlled variables are accounted for, and begin to conduct the experiment.  Update experiment journals as required. | Students demonstrate the ability to set up an experiment.  Students demonstrate research and experimentation skills, including identifying and controlling variables in an experiment. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **Student**  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 5 and 6

Table – Design for space: Critical problem-solving weeks 5 and 6 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 5 – Technologies in space**  **ST5-5**  Students:   * explain a range of scientific laws and theories related to space * apply fundamental mathematical and statistical techniques related to space. | **Teacher**  Identify aspects of the space environment that differ from Earth’s and relate them to [Newton’s Laws of Motion](https://www1.grc.nasa.gov/beginners-guide-to-aeronautics/newtons-laws-of-motion/), weight, and mass.  Describe space technologies, including:   * space vehicles, such as spacecraft, satellites, space stations and orbital launch vehicles * deep-space communication * in-space propulsion.   Display a [tour of the ISS](https://www.nasa.gov/mission_pages/station/main/suni_iss_tour.html).  **Students**  Explore an aspect of space technology and the laws that govern their operation. For example, Kepler’s Laws, Law of Universal Gravitation, orbital velocity, escape velocity, or the [expanding universe](https://www.jpl.nasa.gov/edu/teach/activity/math-of-the-expanding-universe/).  Provide a mathematical or statistical example to explain the laws governing the space technology.  **Extension**  Explore [mathematical applications](https://www.nasa.gov/audience/foreducators/exploringmath/geometry/Prob_FullCircle_detail.html) of the relevant laws, including calculations of velocity and force due to gravity. This could include [applications of pi](https://www.jpl.nasa.gov/edu/nasapidaychallenge).  Build a [model of the ISS](https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Build_the_Station_Simulation.html) or use CAD/CAM to model parts of a space station. Using a standard size joiner, students design and build different parts of the space station and assemble as a class.  Utilise [ISS Minecraft lessons](https://education.minecraft.net/en-us/resources/science-subject-kit/international-space-station).  Describe [vapour-pressure deficit (VPD)](https://en.wikipedia.org/wiki/Vapour-pressure_deficit) as an important principle related to plant growth and life in any environment. | Students can identify a range of technologies in space.  Students can describe the operation of a space technology with reference to the laws governing the space environment.  Students can use statistical and mathematical techniques to support their understanding of the laws governing space technology, for example, solving mathematics problems relating to Newton’s Laws. | Perform calculations using mathematical formulae relevant to the studied laws for higher ability students. |
| **ST5-10**  Students:   * explain the effects of emerging space technologies * investigate factors and decisions which result in successful and failed business ventures. | **Teacher**  Review historical developments in space technologies. Discuss the advantages of autonomous vehicles, uncrewed probes, and reusable booster rockets.  Examine private sector space ventures, for example, the SpaceX, Blue Origin, Virgin Galactic, Artemis missions.  Discuss First Nations Australians' perspectives on space.  **Students**  Research an emerging space technology and identify its advantages, with reference to an example.  Investigate a failed space venture and explain why the venture failed.  Investigate traditional First Nations Australians’ perspectives, for example:   * How do First Nations Australians use celestial objects as a navigational tool? * What techniques or technologies do First Nations Australians use to measure time and predict environmental changes?   Update experiment journals as required. | Students can identify the benefits of emerging space technologies.  Students debate the business models of private ventures and examine the ‘space for space’ business opportunities. | Discuss cultural perspectives from Indigenous communities from other countries. Allow students to explore cultural and historical perspectives based on their own backgrounds. |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 6 – Background research**  **ST5-2**  Students:   * apply appropriate research models and methodologies to gather valid reliable data * critically assess and evaluate information. | **Student**  Conduct research to explain scientific concepts related to the selected space problem experiment. | Student research demonstrates their understanding of the identified scientific concepts, and how they relate to their experiment. | (Add adjustments and registration) |
| **ST5-8**  Students:   * develop and evaluate creative, innovative, and enterprising solutions to a range of complex problems. | **Teacher**  Revisit the equipment needed to complete the selected space problem experiment.  **Student**  Create a scientific diagram of the experimental setup. This includes labels for components and is drawn as a cross section.  Update experiment journals as required. | Students can produce quality scientific diagrams with labelled components. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 7 and 8

Table – Design for space: Critical problem-solving weeks 7 and 8 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 7 – Space problem experiment data analysis**  **ST5-8, ST5-9**  Students:   * investigate software and computing technologies to simulate and/or analyse data in contemporary business and industry contexts for the purposes of making data-informed recommendations * use statistics and probability to analyse data and support decision making * create visual representations of data to support evidence-based decision making * explore statistical functions of spreadsheets and/or graphing calculators. | **Teacher**  Describe how to compile data into a database using appropriate software.  Demonstrate how to calculate averages using formulae.  Demonstrate how to produce graphs using the collected data.  Demonstrate how to add axes labels, line of best fit, and other relevant additional information.  Demonstrate how to effectively display data for industrial and business contexts.  **Students**  Collate all collected data from their space problem experiment.  Calculate average data from multiple trials using formulae.  Produce graphs to compare the dependent and independent variables from the experiment. | Students can use software to produce tables, make calculations, and produce graphs that communicate the outcome of their experiment.  Students can analyse data to interpret trends and errors. | (Add adjustments and registration) |
| **ST5-8**  Students:   * assess the logic and validity of arguments * critically assess and evaluate information * critically assess the design of data visualisations to effectively inform and persuade. | **Teacher**  Describe how to interpret graphs for errors in measurement, as well as any trends in data.  Explain the importance of accuracy and reliability in data collection, with reference to repetition when conducting experiments.  **Students**  Analyse data collected from the experiment for trends and identify any potential errors in data collection.  Explain any trends in the data in relation to environmental factors that were controlled or variable. These may include weather, daylight hours, fluctuation in temperature.  Update experiment journals if still collecting data from experiments. | Students can analyse data to interpret trends and errors.  Students can explain trends and errors by analysing external factors. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 8**  **ST5-9**  Students:   * critically assess and evaluate information. | **Teacher**  Revise the concepts of validity, reliability, and accuracy with reference to scientific investigations.  Assess and provide feedback on the validity, reliability, and accuracy of the information collected.  Relate background research to the results of the experiment.  **Students**  Evaluate the results of the experiment with reference to data, graphs, trends, and observations.  Assess the validity, reliability, and accuracy of the information collected.  Relate background research to the results of the experiment. | Students can evaluate results from a scientific experiment.  Students can assess information and data for validity, reliability, and accuracy. | (Add adjustments and registration) |
| **ST5-5**  Students:   * describe a range of everyday technologies that have emerged out of space research, and their impact on society * outline the types of technologies used to travel beyond Earth’s atmosphere * discuss the impact of advances in science and technology related to space exploration. | **Teacher**  Introduce technologies that have resulted from historic space research programs, for example, battery powered (cordless) tools.  Revise primary and secondary methods of research.  Suggest reliable sources for investigation, for example, the Powerhouse Collection Education Sets on [space technologies](https://collection.maas.museum/set/8117) and the [impact on society](https://collection.maas.museum/set/8119).  Provide students with leading questions for their research, for example:   * Which technologies have had the biggest impact on space travel? * What can be learnt from specific objects from past missions? * How have space technologies impacted life on Earth? * How does astronomical knowledge inform First Nations Australians’ trade and economic practices?   Specify several technologies to be researched by students in the following activity.  **Students**  Research historical technologies that have been developed or used for space travel.  Research historical technologies that have emerged from space exploration.  Describe space technologies and the impact they have had on society on Earth.  **Extension**  Produce an infographic or digital resource that summarises technologies and their impact on space research and exploration. | Students can conduct secondary research to collect information.  Students can describe historical space technologies and explain their relevance to space research and exploration.  Students can predict possible future outcomes of their space problem experiment if they were to be taken to scale in the future. | Provide a scaffolded presentation or adjust the number of technologies to be researched based on student ability. |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 9 and 10

Table – Design for space: Critical problem-solving weeks 9 and 10 learning sequence

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| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 9 – Define and identify the environmental monitoring experiment**  **ST5-2, ST5-3**  Students:   * investigate entrepreneurial mindsets and processes * apply critical thinking and problem-solving strategies to analyse, develop and evaluate solutions * work individually or collaboratively to apply critical thinking and problem-solving strategies to design solutions to complex problems. | **Teacher**  Outline the design brief and tasks for the next phase of the learning sequence, to design and program a prototype experiment that will monitor environmental factors such as temperature, humidity, light levels, force of gravity. Link this to the simulation of ISS-based experiments.  Show students examples of the microcontroller (or similar) on which the prototype will be based.  Split students into teams and introduce an assessment task, the design pitch.  Explain the requirements of a design pitch:   1. Define the problem 2. Describe the solution 3. Team roles 4. Cost breakdown 5. Project plan.   Browse through [existing experiments](https://www.nasa.gov/mission_pages/station/research/experiments_category) being conducted on the ISS.  Discuss and show examples of a clear problem statement.  **Students**  Produce a clear statement describing the problem to be solved.  Develop a [mind map](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/542) with initial ideas for the project to design, construct, and test an environmental monitoring experiment. | Students understand the requirements of a design pitch.  Students can define and identify aspects of a design process.  Students record initial ideas in a [mind map](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Browser?clearCache=3bd2b92d-71ac-627-8585-49a74e9bfbf2). | Consider accessibility needs and alternative options when using graphical organisers like mind maps. |
| **ST5-5**  Students:   * outline Australian and international historical perspectives in space and their impact on society * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space-related scenarios. | **Teacher**  Identify a CubeSat and the Nanorack platform that existing experiments are based on.  Identify a CubeLab platform.  Introduce [Cuberider](https://collection.maas.museum/object/548512) as a previous Nanorack design used for a series of student experiments. Compare this to the current project where students will be building the hardware, not just coding.  Explain the [size requirements [PDF 4.2MB]](https://www.nasa.gov/sites/default/files/atoms/files/nasa_csli_cubesat_101_508.pdf) of a Nanorack based CubeSat – 100 mm x 100 mm x 100 mm and a maximum weight of 2 kg per cube. Multiple cube sizes can be used, but this would dramatically increase cost.  Discuss the differences between a standalone CubeSat versus a Nanorack experiment on the ISS to differentiate requirements of each.  Model and discuss how to develop success criteria and how they will need to be evaluated at the end of the engineering design process.  **Students**  Define the success criteria for the project.  Review prior knowledge and experience that could be used to solve this problem.  Research a range of other CubeSat or CubeLab experiments currently being used, or from past missions, to inspire ideas. | Students can recall an Australian innovation in space.  Students can identify the requirements for a Nanorack experiment in space.  Students identify an experiment to perform, based on inspiration provided from previous examples. | (Add adjustments and registration) |
| **ST5-5**  Students:   * describe the characteristics and uses for satellite technologies, and investigate the impact of satellite lifespan * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Teacher**  Revisit Nanorack based CubeSats and CubeLabs, and the experiments they perform.  Use a tool such as the [Esri Satellite Map](https://geoxc-apps2.bd.esri.com/Visualization/sat2/index.html) to view the details of different satellites in space, including their size and countries of origin. Discuss the effects of space junk after a satellite is no longer in use. Identify that the satellite map is not to scale and that the size of the satellites and distance between them is also not in proportion.  Describe the role of orbital inclination on observations of Earth from space.  Demonstrate how to identify constraints in a project, referencing the identified CubeSat and CubeLab experiments.  **Students**  Investigate sensors used in a range of CubeSat or CubeLab experiments, and the equivalent microcontroller components that could be used in an environmental monitoring prototype.  Develop a resource list, including tools, materials, and people for the project.  Identify constraints of the project based on their chosen environmental monitoring experiment. | Students can use a graphical map to identify types of satellites in orbit.  Students can describe the effects of space junk on the future of space travel and research.  Students can describe the main components of a functioning CubeSat or CubeLab.  Students can identify resources required to solve problems.  Students can identify constraints of their project. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |
| **Week 10**  **ST5-4, ST5-7, ST5-8**  Students:   * explain how information systems are used to improve decision making * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space related scenarios. | **Teacher**  Outline the microcontroller to be used for the project, for example, Arduino, micro:bit, Raspberry Pi.  Outline the components available to students, for example, sensor types, servos, displays, dataloggers.  Explain how these components send data to the device which can be viewed or logged.  Explain how microprocessors can collect data that can be used for intelligent systems such as weather forecasting.  **Students**  Research the cost and availability of the components required to complete their environmental monitoring experiment. | Students can research to explain the function and cost of the identified microprocessor and attached components.  Students understand the link between microprocessors and their components in logging data.  Students can explain how microprocessors can collect data that can be used for intelligent systems. | (Add adjustments and registration) |
| **ST5-7**  Students:   * use project management techniques to plan solutions related to space | **Teacher**  Revise roles within teams and allocate roles to team members, explaining the importance of using timelines and set roles as part of planning.  Revise project management approaches from [iSTEM fundamentals](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4).  Prescribe a template for planning the timeline for creating the environmental monitoring experiment, such as a Gantt chart.  Identify and describe a range of team roles available to students, such as project manager, design lead, and code development lead.  **Student**  Create a basic project plan and assign team roles. | Students use project management strategies to plan a timeline of activities for their project.  Students work collaboratively to plan and complete set tasks. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**  Monitor the progress of student reflections.  **Student**  Assess what they know, what they need to know, and how they might bridge any gaps in understanding that exists.  Relate this to team roles with specific tasks to be completed by individual members.  Reflect on what needs to be achieved in the time allocated.  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Week 11

Table – Design for space: Critical problem-solving week 11 learning sequence

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| ****Outcomes and content**** | ****Teaching and learning**** | ****Evidence of learning**** | ****Adjustments and registration**** |
| ****Week 11 – Idea generation and brainstorm****  ****ST5-2, ST5-3, ST5-4****  Students:   * apply critical thinking and problem-solving strategies to analyse, develop, and evaluate solutions * work individually or collaboratively to apply critical thinking and problem-solving strategies to design solutions to complex problems * work individually and collaboratively and apply engineering design processes to build practical solutions to space related scenarios. | **Teacher**  Provide students with a scaffold like a mind map for brainstorming and generating ideas for their space-based experiment.  Revise brainstorming techniques introduced in [iSTEM fundamentals](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4).  Explain that the experiment must collect data from sensors. The purpose of collecting the data is to understand more about space or life in space.  Demonstrate divergent and convergent thinking techniques to produce creative ideas.  **Students**  Discuss, ‘What critical knowledge is required for a mission to Mars?’  Work collaboratively in teams to develop ideas and plan for an environmental monitoring prototype.  Produce several thumbnail sketches and annotated drawings of the initial ideas that include microcontrollers and required components.  Apply problem-solving tools to produce a variety of creative ideas, for example, divergent thinking, speed thinking, and mind maps.  Apply problem-solving tools to evaluate and develop solutions. For example: convergent thinking, speed thinking, hits, clustering, Point, card sort, evaluation matrix, paired comparison analysis. | Students document the application of critical thinking and problem-solving to complex problems related to space, using divergent and convergent thinking tools.  Students produce drawings and sketches that clearly demonstrate design ideas. | Consider accessibility needs and alternative options when producing sketches. |
| ****ST5-2, ST5-3, ST5-4****  Students:   * work individually or collaboratively to apply critical thinking and problem-solving strategies to design solutions to complex problems * work individually and collaboratively and apply engineering design processes to build practical solutions to space related scenarios. | **Teacher**  Discuss the constraints of the design brief.  Revisit [size requirements [PDF 4.2 MB]](https://www.nasa.gov/sites/default/files/atoms/files/nasa_csli_cubesat_101_508.pdf) of a Nanorack based CubeSat – 100 mm x 100 mm x 100 mm and a maximum weight of 2kg per cube – that the components of the environmental monitoring experiment must comply with.  Identify the possible stresses on a CubeSat or CubeLab during launch, such as vibration, temperature, radiation, and acceleration, that must be considered in the design.  Identify the range of available technologies and techniques for the construction of a Nanorack-based CubeSat housing.  **Students**  Investigate potential technologies and techniques that could be used in the solution.  Use convergent thinking tools to produce at least 3 potential design solutions.  Decide on final chosen solution for their environmentalmonitoring experiment and set specifications for the microcontroller, components, and housing. | Students document the application of critical thinking and problem-solving to complex problems related to space.  Students demonstrate what technological resources may be required to solve the identified problem.  Students identify techniques that they could use to develop solutions to problems.  Students set final environmental monitoring prototype specifications. | Consider accessibility needs and alternative options when using graphical organisers like mind maps. |
| ****Weekly reflection**** | **Teacher**  Monitor the progress of the student reflections.  **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Identify how they solved different problems related to the environmental monitoring prototype.  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 12 and 13

Table – Design for space: Critical problem-solving weeks 12 and 13 learning sequence

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| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| ****Week 12 – Design****  ****ST5-6****  Students:   * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems related to space * work individually and collaboratively and apply engineering design processes to build practical solutions to space related scenarios. | **Teacher**  Revise design solutions, synthesise ideas, and plan using skills from [iSTEM fundamentals](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4).  **Students**  Apply a range of design techniques to produce solutions, for example, algorithms, flowcharts, storyboards, SWOT.  Produce a range of annotated design drawings of their chosen solution, for example, sketches, rendering, detailed drawings.  Use a computer-aided design (CAD) package to produce working drawings or illustrations of the design solutions.  Develop a mission statement that explains the purpose of the mission and the desired outcome.  **Extension**  Research the real costs of sending the mission to space, including parts and launch. | Students demonstrate the use of convergent thinking techniques.  Students demonstrate a range of design techniques in their solutions to space-based problems.  Students communicate graphically innovative solutions to problems related to space using a range of drawing techniques, including CAD. | (Add adjustments and registration). |
| ****Weekly reflection**** | **Teacher**  Monitor the progress of student reflections.  **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Describe how the team has worked together to decide upon the final design solution.  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |
| ****Week 13 – Design****  ****ST5-6, ST5-8****  Students:   * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems related to space * investigate entrepreneurial mindsets and processes | **Teacher**  Discuss how to produce an effective pitch, giving examples of effective pitching.  Demonstrate the use of a range of presentation technologies, including video.  **Student**  Collate planning information including sketches and examples of other missions for the presentation.  Collaborate to develop a verbal presentation for the project pitch, where each member presents the key information as part of their role in the team.  Teams present their pitch to the class. | Students present a structured, well-presented, and researched pitch that clearly communicates their chosen solution. | (Add adjustments and registration). |
| ****ST5-6, ST5-8****  Students:   * investigate the nature of work undertaken in the space industry * investigate the pathways into space careers.   ****Extension:**** 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 a range of careers related to the space industry. Career pathways can be found at the [Australian Space Discovery Centre](https://www.industry.gov.au/australian-space-discovery-centre/pathways-for-a-career-in-space) or [Careers with STEM](https://careerswithstem.com.au/category/space).  Identify the vast number of pathways into the industry, with a focus on tertiary education. Explain the competitive nature of the industry and prevalence of small start-up companies.  Show a range of career profile videos available at [NASA](https://www.nasa.gov/stem/nextgenstem/nasa-stem-stars/index.html).  **Students**  Research and describe 3 career pathways related to the Australian space industry and the education pathways into each.  **Extension**  Research the requirements to become an astronaut or space scientist and summarise into key points. Determine how this may be achievable for an Australian citizen. | Students will be able to recall different types of space careers and describe the pathways into the Australian space industry. | (Add adjustments and registration). |
| ****Weekly reflection**** | **Teacher**  Monitor the progress of student reflections.  **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Relate the importance of collaboration and communication skills in space careers to the development of their project pitch.  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 14 to 16

Table – Design for space: Critical problem-solving weeks 14 to 16 learning sequence

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| ****Outcome and content**** | ****Teaching and learning**** | ****Evidence of learning**** | ****Adjustments and registration**** |
| ****Week 14 – Coding****  ****ST5-6****  Students:   * program robotics technologies and physical computing platforms to create solutions. | **Teacher**  Revise introductory coding from [iSTEM fundamentals](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4).  Explicitly demonstrate coding techniques necessary to read data from a single sensor and display it in the serial monitor.  Repeat with other sensors and highlight the lines of code that are the same between the 2 programs. Explain the purpose of these parts.  Explain the purpose of a ‘delay’ in reading and the use of an ‘if’ statement.  Explicitly demonstrate how to read data from multiple sensors at once and display on the serial port or external display.  **Students**  Complete a range of coding exercises that detect and display sensor data.  **Extension**  Demonstrate how to capture sensor data, using a data streamer or similar. | Students can demonstrate basic coding techniques.  Students can collect data using a microcontroller and sensor and display it. | For higher ability students, provide a self-paced task to complete, such as programming a weather station. |
| ****Weekly reflection**** | **Teacher**  Monitor the progress of student reflections.  **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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |
| ****Week 15 – Prototype****  ****ST5-6, ST5-8****  Students:   * program robotics technologies and physical computing platforms to create solutions * demonstrate practical skills, safely using appropriate tools, equipment, and techniques to produce models, prototypes, or experiments. | **Teacher**  Explain a simple circuit diagram using the components from previous activities.  Provide diagrams of the components available, showing the pin allocations to make electrical connections.  Demonstrate the importance of connecting pins correctly in terms of the 5V, ground, and communication pins, while connecting individual sensors to a microcontroller.  Describe the different connection types of hardware, including I2C, digital, and analogue. Explain the differences between them.  **Students**  Plan a circuit diagram of the required components for the chosen environmental monitoring experiment.  Construct the prototype circuit using breadboards or other connections.  Test components individually using a basic serial print code to check their connections. | Students can produce a basic circuit diagram to explain the operation of a prototype.  Students assemble a functioning microcontroller-based prototype.  Students can use basic programming techniques in the completion of a prototype design. | (Add adjustments and registration). |
| ****Weekly reflection**** | **Teacher**  Monitor the progress of student reflections.  **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Identify some of the challenges when prototyping the circuit and relate them to the size and weight constraints.  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |
| ****Week 16****  ****ST5-9****  Students:   * create or simulate communication links between devices * program robotics technologies and physical computing platforms to create solutions. | **Teacher**  Explain how satellites send data back to ground stations.  Demonstrate how individual sensors can be combined to run on a single microcontroller, including how to combine code.  Demonstrate how data can be captured from the microcontroller’s sensors, either wired (SD Card) or wirelessly (Bluetooth).  **Students**  Identify additional components that would be required to send data wirelessly from their prototype to a computer.  Adapt the coding developed for individual sensors into a single program.  Test and modify the code to obtain a serial print of all data.  Modify the code to use a data logger or method of wireless transmission that would emulate wireless transmission from space.  Test the transmission and/or recording of data. | Students can describe how a communications link between their prototype and a ground station would work.  Students can produce code to physically manipulate a robotic system. | (Add adjustments and registration). |
| ****Weekly reflection**** | **Teacher**  Monitor the progress of student reflections.  **Students**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Identify key hurdles that were overcome in the iteration of coding.  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 17 and 18

Table – Design for space: Critical problem-solving weeks 17 and 18 learning sequence

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| ****Outcomes and content**** | ****Teaching and learning**** | ****Evidence of learning**** | ****Adjustments and registration**** |
| ****Week 17 – Prototype****  ****ST5****  Students:   * demonstrate practical skills, safely using appropriate tools, equipment and techniques to produce models, prototypes, or experiments. | **Teacher**  Provide induction for the safe use of required tools and equipment by students, according to school processes.  **Students**  Complete any required safety tests and demonstrations.  Revisit the size requirements of a Nanorack based CubeSat.  Create a physical prototype that includes the microcontroller and required components using appropriate tools and equipment, based on previous planning drawings.  This may include soldering components to a prototyping board or custom PCB.  Create or research power supplies suitable for the experiment. | Students complete any required safety tests.  Students demonstrate practical skills, safely using appropriate tools, equipment, and techniques, to produce a working prototype that reflect planning drawings. | (Add adjustments and registration). |
| ****ST5-5, ST5-9****  Students:   * investigate the use of critical thinking and problem-solving in business and industry * investigate technologies used for space operations. | **Teacher**  Demonstrate how to analyse the data output of sensors and how to assess whether it would achieve the aim.  **Students**  Investigate data analysis used in space, including removing corrupt data, sample sizing validity of manipulated data, and technologies used for space operations.  Investigate how NASA uses critical thinking and problem-solving. | Students can describe how industry uses data analysis and problem-solving techniques. | (Add adjustments and registration). |
| ****Week 18 – Prototype****  ****ST5-1, ST5-3, ST5-6****  Students:   * use a range of technologies for the purposes of producing space related prototypes, models, or experiments * design and build a system to solve real-world space-related problems * demonstrate practical skills, safely using appropriate tools, equipment, and techniques, to produce models, prototypes, or experiments. | **Teacher**  Provide supervision and troubleshooting advice for student prototype construction.  **Students**  Continue design and construction of components for the environmental monitoring experiment prototype, using a range of different technologies. | Students demonstrate practical skills, safely using appropriate tools, equipment, and techniques, to produce prototypes that reflect planning drawings. | (Add adjustments and registration). |
| ****ST5-1, ST5-3, ST5-6****  Students:   * 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. | **Student**  Investigate design competitions or displays that the project could be entered into, for example, the Powerhouse: Future Space program.  Visit the [Powerhouse](https://www.maas.museum/powerhouse-museum/) website or undertake a virtual tour to view space-related technologies, including Cuberider.  **Extension**  Students actively seek advice or feedback on their prototype from an industry or university representative. | Students identify a source of feedback for their environmental monitoring experiment.  Students can identify similar space projects that are displayed at the Powerhouse. | (Add adjustments and registration). |
| ****ST5-10****  Students:   * outline Australian and international historical perspectives in space and their impact on society. | **Teacher**  Provide reliable sources of information, such as the Powerhouse Collection Education Set on [Historical Perspectives](https://collection.maas.museum/set/8118), or the technological impact of the [Apollo mission](https://www.nasa.gov/stem-ed-resources/technological-impact-of-the-apollo-program-0.html).  **Students and Teacher**  Discuss advances in manufacturing techniques and materials research that have led to major advancements in space technology.  **Student**  Investigate Australian and international historical perspectives in space.  Compare and contrast historical examples to modern space technology.  Investigate traditional First Nations Australians’ perspectives on space.  Describe some of the major challenges in space travel and research in the 1900s. | Students can describe the historical perspectives and technological impact of space research on society. | (Add adjustments and registration). |
| ****Weekly reflection**** | **Teacher**  Monitor the progress of student reflections.  **Student**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Describe how well the group worked together to construct the prototype.  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |

### Weeks 19 and 20

Table – Design for space: Critical problem-solving weeks 19 and 20 learning sequence

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| ****Outcomes and content**** | ****Teaching and learning**** | ****Evidence of learning**** | ****Adjustments and registration**** |
| ****Week 19 – Iterate and evaluate****  ****ST5-3, ST5-8****  Students:   * demonstrate practical skills, safely using appropriate tools, equipment, and techniques, to produce models, prototypes, or experiments. | **Teacher**  Provide supervision and troubleshooting advice for student prototype construction.  **Student**  Finalise the design and construction of components for the environmental monitoring experiment prototype, using a range of different technologies based on evaluations of design solutions.  Run the environmental monitoring experiment to gather data over a period of time. | Students demonstrate practical skills, safely using appropriate tools, equipment, and techniques, to produce prototypes.  Students collect and store data for future use. | (Add adjustments and registration). |
| ****ST5-7****  Students:   * apply critical thinking and problem-solving strategies to analyse, develop, and evaluate solutions. | **Teacher**  Outline a series of tests that prototypes will need to undergo to demonstrate suitability for a simulated space launch.  **Student**  Test the physical structure of the prototype for its suitability for launching into space.  Evaluate whether all components remain intact and working after exposure to heat, cooling, and shaking.  Test whether size and weight restrictions are met by all components, including the connection types and communication methods of the device.  Analyse and evaluate the impact of the solution on the environment and society. | Students test and evaluate prototypes for suitability to meet set constraints and record all outcomes.  Students evaluate the impact that their environmental monitoring experiment could have on the environment and society if launched into space. | (Add adjustments and registration). |
| ****ST5-1, ST5-3, ST5-5, ST5-9****  Students:   * demonstrate innovation and entrepreneurial activity and communicate solutions * work individually and collaboratively to apply an engineering design process to complete real-world problems and challenges to space-related scenarios. | **Student**  Collect and organise data taken from experimentation and testing.  Apply critical thinking and problem-solving techniques to iterate and improve on prototype design, which is based on the results of experimentation and testing. | Students interpret experimentation data, using appropriate mathematical and statistical methods to inform design decisions.  Students record any iterations or suggested improvements on their tested prototype. | (Add adjustments and registration). |
| ****Weekly reflection**** | **Teacher**  Monitor the progress of student reflections.  **Student**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Describe any limitations of the prototype and how that may be overcome.  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. | Procedural recounts can be prepared on paper or digitally, including speech-to-text or voice recording. |
| ****Week 20 – Evaluate and communicate****  ****ST5-7, ST5-8****  Students:   * collect, record, and analyse accurate, repeated measurements in the process of testing models, prototypes, and experiments * apply critical thinking and problem-solving strategies to analyse, develop, and evaluate solutions. | **Student**  Complete an evaluation of the final prototype design, using data analysis.  Evaluate the prototype using the success criteria set at the beginning of the engineering design process.  Suggest improvements that could be made to future iterations of the design.  Discuss the commercial viability of their design solutions. | Students demonstrate critical thinking, creativity, problem-solving, entrepreneurship, and engineering design skills in presenting their prototypes and documentation.  Students produce final evaluation, including data analysis, comparison between design drawings and final prototype, and suggested improvements. | (Add adjustments and registration). |
| ****ST5-10****  Students:   * 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**  Organise an industry program and career development opportunity, for example, an excursion, incursion, panel to assess prototypes, or online course.  Options for virtual activities include the [Australian Space Discovery Centre](https://www.industry.gov.au/australian-space-discovery-centre/school-sessions-and-holiday-programs) and the [PULSE at Parkes](https://research.csiro.au/pulseatparkes/) Radio Telescope.  **Student**  Take part in industry programs and career development opportunities. | Students demonstrate entrepreneurship.  Students demonstrate deep knowledge of the Australian and international space sector. | (Add adjustments and registration). |

## 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 202a: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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