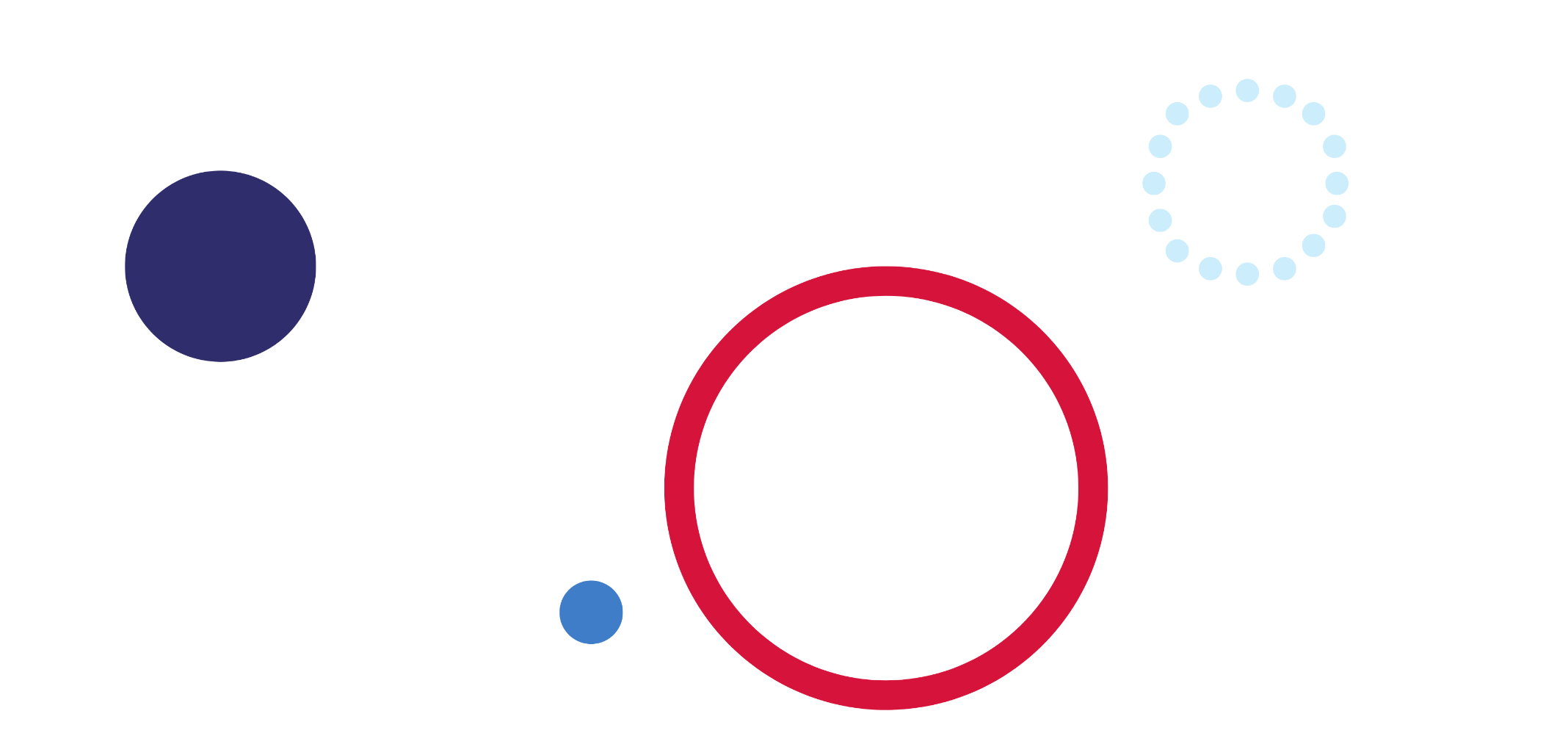
# iSTEM – aeronautical engineering



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## Aeronautical engineering

Aeronautical engineering involves the design, production, testing and maintenance of aircraft, aerospace vehicles and their systems. This generally includes conventional fixed-wing aircraft as well as gliders, helicopters, hovercraft, spacecraft, balloons and drones. Aeronautical engineering has a range of recreational, commercial and military applications. Aeronautical and aerospace engineering is a multidisciplinary profession. There are many different types of aviation professionals and various pathways into these careers.

In this specialised topic, students will develop skills and knowledge used in the aeronautical engineering professions by completing inquiry-based and problem-based learning tasks.

To complete this topic, students should follow design thinking processes. Curriculum Secondary Learners have produced a sample [iSTEM engineering design process and engineering report guide](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4) to scaffold students’ personal learning journey.

### Duration of learning

Indicative time – 25 hours.

### Inquiry question

How can we produce aeronautical engineering design solutions that are both safe and efficient?

### 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).

### Core resources

* Graph paper and geometric tools: ruler, compass, protractor or a technology alternative
* Basic model aircraft
* Electric motors
* Balsa (various sizes)
* Wire, solder, soldering iron, plastic wheels
* Computers with various software including spreadsheet, CAD and video editing
* Digital camera to capture photos and videos
* 1.25 L PET bottles and other materials for fins and nose cone
* Cloth tape or hot glue for joining
* Altimeter (data logger)
* Bottle rocket launching device
* Vinyl cutter (optional)
* Vacuum forming machine (optional)
* Laser cutter (optional)
* 3D printer (optional)

### Rationale

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

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

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

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

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

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

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

### Aim

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

### Purpose and audience

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

### When and how to use this document

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

## Learning sequences

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

### Weeks 1 and 2

Table 1 – aeronautical engineering weeks 1 and 2 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 1 – introduction**  **ST5-5, ST5-10**  Students:   * work individually and collaboratively to apply an engineering design process to create solutions to aeronautical engineering design problems * develop an understanding of aeronautical engineering and the aerospace industry * investigate the nature of work and pathways into the aeronautical engineering and aerospace professions. | **Teacher**  Outline the aeronautical engineering topic and describe the design challenges to be completed:   * paper plane (practical) * balsa glider (practical) * bottle rocket (practical) * engineering report.   Revise stages of the [iSTEM engineering design process [PDF 2.9MB]](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4).  Provide students with a copy of the [iSTEM engineering design process: A guide for teachers [DOC 1.09MB]](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-engineering-design-process.docx).  Discuss how technological innovations have impacted the aeronautical engineering and aerospace industry.  Access the [Careers with STEM video (4:49)](https://education.nsw.gov.au/teaching-and-learning/curriculum/stem/stem-curriculum-resources/careers-with-stem).  Introduce students to the [careers with STEM](https://careerswithstem.com.au/) website.  **Students**  Individually or in pairs, read a different career profile article related to aerospace engineering from the Careers in STEM magazine or website. Use a [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645) activity to identify the skills required to work in the aerospace industry.  **Extension (optional)**  Explore Newton’s third law of motion by constructing a [balloon powered hovercraft](https://www.scienceworld.ca/resource/balloon-hovercraft/) using a balloon and CD.  **Visit** an aviation **museum, for example:**   * Temora Aviation Museum * HARS Aviation Museum in Albion Park or Parkes * Fighter World in Williamtown. | Students can:   * identify design tasks to be completed and the requirement to complete an engineering report * describe a range of historical innovations in the aeronautical engineering and aerospace industries * outline career pathways associated with the aeronautical engineering and aerospace professions. | Use closed captions when viewing video to assist understanding and vocabulary building. Pause video to assess student understanding at appropriate points.  Provide a worksheet with key terms to assist with vocabulary building and knowledge acquisition.  Provide explicit instruction on how to navigate websites.  Teacher to model using the [Think-Pair-Share](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/645) technique for a specific example and then get students to attempt the technique unassisted. |
| **Traditional Aboriginal techniques**  **ST5-5**   * examine traditional technologies used by Aboriginal and Torres Strait Islander peoples to solve problems * principles and laws of physics * Bernoulli’s principle. | **Teacher**  Introduce the boomerang as a traditional aeronautical engineering technology used by Aboriginal and Torres Strait Islander peoples.  Demonstrate [Bernoulli’s Principle [PDF 8.4MB]](https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwiB6sL2h7T7AhWKxHMBHWLgCs0QFnoECBIQAw&url=https%3A%2F%2Fwww.nasa.gov%2Fsites%2Fdefault%2Ffiles%2Fatoms%2Ffiles%2Fbernoulli_principle_5_8.pdf&usg=AOvVaw3o6IKiO2RtH2dNTy2zgGzv) using a diagram and experimentation. Teacher may need to complete a risk assessment.  **Students**  Research a traditional technology or technique used by Aboriginal and Torres Strait Islander peoples related to aerospace and present to the class.  Investigate traditional inventions and innovations from Australia’s First Peoples.  Complete Bernoulli’s principle [Floating Ping Pong Ball [PDF 364KB]](https://orise.orau.gov/resources/k12/documents/lesson-plans/floating-ping-pong-ball.pdf) experiment activity.  **Extension**  In consultation with local Aboriginal Education Consultative Group (AECG) and/or community leaders, ask traditional owners to demonstrate use of the boomerang and describe how it is traditionally made and works.  Demonstrate the safe use of tools and machinery required to construct a boomerang.  Organise and facilitate access to workshop which may include marking out, cutting, and joining tools.  Construct and test a plywood boomerang.  Complete a risk assessment using tools such as RiskAssess to test the boomerang. | Students can identify traditional technologies and techniques used by Aboriginal and Torres Strait Islander peoples.  Students can describe the basic principles of how a boomerang works.  Students can identify concepts of lift and gyroscopic precession as they relate to boomerangs.  Students can describe Bernoulli’s principle. | Skim and scan document to help orientate students. Demonstrate active reading, such as pre-read, read and re-reading for processing, of information to extract relevant information.  Assist students during research, for example:   * [The Boomerang is curved to fly](https://australian.museum/learn/cultures/atsi-collection/boomerangs/the-boomerang-is-curved-to-fly/) * [Why a Boomerang flies](https://australian.museum/learn/cultures/atsi-collection/boomerangs/why-a-boomerang-flies/) * [The returning Boomerang: how it flies](https://australian.museum/learn/cultures/atsi-collection/boomerangs/the-returning-boomerang-how-it-flies/).   Give students options to work in groups or individually to achieve accurate fine motor skills of marking out, cutting, and using tools. |
| **Historical perspectives**  **ST5-5**   * outline historical perspectives in aviation that have impacted the aeronautical industry and society * critically evaluate the impact of aviation on society, environment and people’s lives * describe the contributions that aviation professionals make to society. | **Teacher**  Present [The History Of Aviation Explained (26:27)](https://www.youtube.com/watch?v=VAd3z06N_mE).  **Teacher and students**  Discuss the impact of modern aviation industry on society, the environment and on people’s lives. Divide the class, and have students debate the positive and negative impacts.  Record concepts and related ideas using a concept map to organise ideas.  **Students**  Create a basic timeline showing the most significant historical developments in the aviation industry.  Investigate and record the contributions aviation and aerospace professionals have made to society on a mind map. | Students can demonstrate both the positive and negative aspects of the development of modern aviation industry and its effects on society, the environment and people’s lives.  Student mind maps describe the major contributions that aviation professionals have made to modern society.  Timeline of the aviation industry, demonstrating students understanding of key historical events that have impacted the aeronautical industry and society in general. | Use closed captions when viewing video to assist understanding and vocabulary building. Pause video to assess student understanding at appropriate points.  Teacher to model using the concept map for a specific example and then get students to attempt technique unassisted.  Provide features in a ‘time marker bank’ and students populate the timeline using the markers in the bank provided by the teacher. |
| **Weekly reflection** | **Students**  Complete weekly reflection using the following steps:   * identify tasks undertaken, new knowledge, understanding or skills * evaluate new knowledge, understanding or skills in the light of previous knowledge * analyse key insights and pose questions regarding future learning. | Students answer reflective questions, for example:   * What did I learn about traditional and historical perspectives of the aviation industry this week? * Did I learn best when receiving information, applying knowledge, or communicating? | Modelling of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.  Procedural recount to be prepared on paper or digitally, including speech to text or voice recording. |
| **Week 2 – how planes fly**  **ST5-4, ST5-5**  **Students:**   * work individually and collaboratively to apply an engineering design process to create solutions to aeronautical engineering design problems * explain a range of fundamental aerodynamic principles related to flight * use principles and laws of physics, Bernoulli’s principle, Newton’s laws. | **Teacher**  Introduce a design challenge to produce a paper plane with the longest flight duration.  Describe the components of an [engineering report [DOC 1.57MB]](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-writing-engineering-reports-teachers-guide.docx).  Define the term ‘aerodynamics’.  Outline the 4 basic forces within aerodynamics:   * lift * thrust * drag * weight.   Present [Aerodynamics Explained by a World Record Paper Airplane Designer (16:35)](https://www.youtube.com/watch?v=3KqjRPV9_PY).  **Students**  Start to prepare an engineering report for the 3 design challenges. The first entry in the report will be for a paper plane design challenge.  Investigate paper plane designs online.  Access the 3 videos listed below and write a summary of how the aerodynamic principle affects lift:   * [Coanda effect (3:48)](https://youtu.be/NvzXKZNJ7ZU) * [Lift According to Newtons 3rd Law, Explained (1:36)](https://www.youtube.com/watch?v=ERF9NMka5Ic) * [Lift and Bernoulli's Principle (2:36)](https://www.youtube.com/watch?v=HmDYbnGnhpA).   **Teacher and students**  Identify the 2 ways in which lift is generated. | Students can recall the components of an engineering report.  Students explain how lift, thrust, drag and weight forces are applied to a paper plane.  Students can describe the Coanda effect, Bernoulli’s principle and Newton’s third law.  Students can describe the 2 ways in which lift is generated. | Use closed captions when viewing video to assist understanding and vocabulary building. Pause video to assess student understanding and discuss pertinent points.  Some students may need explicit teaching of Coanda effect, Bernoulli’s principle and Newton’s third law, rather than the student directed option. |
| **Paper plane challenge**  **ST5-1, ST5-2, ST5-4, ST5-5**  Students:   * identify control surfaces and major components of fixed wing aircraft, for example * fuselage, wing, flap, aileron, elevator, rudder, horizontal and vertical stabilisers * describe the basic movements of an aircraft and the control surfaces that cause this movement, for example * pitch, roll and yaw * design and build a system to solve a real-world aeronautical engineering or aerospace problem. | **Teacher**  Using a model airplane, identify the major components of a fixed wing aircraft. (**Note**: Ensure selected model has traditional control surfaces included).  Using the model, describe how the different control surfaces cause pitch, roll and yaw movements in an aircraft. Refer to [Dynamics of Flight](https://www.grc.nasa.gov/www/k-12/UEET/StudentSite/dynamicsofflight.html#:~:text=Airplane%20wings%20are%20shaped%20to,wing%20up%20into%20the%20air.) by NASA.  Demonstrate safe flight of paper planes to class.  **Students**  Label an image of an aircraft, identifying the major components including control surfaces.  Describe how different control surfaces cause movement in an airplane using an explanation text type.  Produce annotated sketches to describe how the plane designs use aerodynamics principles to fly the longest distance.  Use one or more of the [brainstorming](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/542) tools to develop ideas for the paper plane design challenge. | Students can describe the movements on an aircraft using the terms ‘pitch’, ‘roll’ and ‘yaw’.  Students can demonstrate how the control surfaces are used to cause movement in an aircraft.  Students produce annotated sketches demonstrating their understanding of the aerodynamic principles of flight. | Procedural recount to be prepared on paper or digitally, including speech to text or voice recording.  Provide a glossary of technical language. |
| **Paper plane challenge**  **ST5-1, ST5-2, ST5-4, ST5-5**  Students:   * design and build a system to solve a real-world aeronautical engineering or aerospace problem * work individually and collaboratively to apply an engineering design process to create solutions to aeronautical engineering design problems, for example * paper planes * demonstrate innovation and entrepreneurial activity, and communicate solutions to problems involving aeronautical engineering. | **Students**  Prototype and iterate a range of paper plane designs and test them for distance.  Photograph each design solution for the engineering report.  Test and evaluate each design’s performance based on aerodynamics principles. For example, record maximum height and distance against a high or low lift design.  Communicate results of the paper plane design challenge in the engineering report.  **Note:** View [How To Make 5 EASY Paper Airplanes that FLY FAR (19:58)](https://www.youtube.com/watch?v=54noZe-0B1c) for ideas and inspiration. | Students design a range of aeronautical design solutions using aerodynamic principles.  Students have applied engineering design processes to create a paper plane design.  Students document the results of their use of an engineering design process to create paper plane designs.  Students demonstrate innovation in the completion of their design solutions. | To develop skills when testing planes, provide students with support or individualised adjustments to be able to access and participate on the same basis as peers. |
| **Weekly reflection** | **Students**  Complete weekly reflection by identifying and evaluating new knowledge or skills considering previous knowledge. | Students answer reflective questions, for example:   * What did I learn about plane design this week? * How did I learn best? | Modelling of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task. |

### Weeks 3 to 5

Table 2 – aeronautical engineering weeks 3 to 5 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 3 – balsa glider challenge**  **ST5-4, ST5-5, ST5-7**  **Students:**   * design and build a system to solve a real-world aeronautical engineering or aerospace problem * use project management techniques to plan solutions to aeronautical engineering projects. | **Teacher**  Introduce a balsa glider design challenge.  Outline the design brief for the balsa glider challenge.  Divide class into suitably sized teams and get students to select team roles.  **Note**: Commercially available resources could be used, for example:   * battery powered testing unit * rubber band plane kits.   Alternatively, individual components could be sourced from different suppliers, for example:   * motors * balsa.   **Students**  Working in teams, define the problem to solve and identify the constraints of the balsa plane challenge.  Either as a group or an individual, complete a mind map of initial thoughts and questions regarding the design parameters.  Plan a timeline for the development of the project to be documented in the engineering report, for example:   * identify materials * identify project criteria * identify tools and equipment.   Design, prototype, evaluate and iterate a balsa glider design solution. | Students clearly define the problem to be solved, producing a concise design brief.  Students produce a mind map of initial ideas and thoughts to solve the problem.  Students follow project management techniques to complete tasks on time. | Use examples of project plans to support students. |
| **Research, testing and experimentation**  **ST5-6**  Students:   * design and build a system to solve a real-world aeronautical engineering or aerospace problem. | **Teacher**  Demonstrate the safe use of tools and machinery required to build the base balsa glider.  Organise and facilitate access to workshop which may include:   * marking out, cutting, and joining tools * 3D printing * laser cutting.   Demonstrate how to build the base balsa plane design.  Provide students with materials to construct base balsa glider **and conduct any required safety testing.**  **Students**  **Complete any required safety tests for required equipment.**  Research different balsa glider designs.  In groups, construct a base model balsa glider.  Conduct tests and experimentation of base model balsa glider. | Students produce and test a standard balsa glider design. | Give students options to work individually or in groups. Support groups to divide roles according to student interests and strengths. |
| **Brainstorm and design**  **ST5-1, ST5-2, ST5-3, ST5-4**  Students:   * work individually and collaboratively to apply an engineering design process to create solutions to aeronautical engineering design problems, for example * balsa glider * design and build a system to solve a real-world aeronautical engineering or aerospace problem. | **Teacher**  Outline 2 alternative design challenges, for example:   * high lift, low speed plane * low lift, high speed plane.   **Students**  Decide upon either high or low lift alternative.  Produce a series of annotated design sketches of their ideas.  Produce sketches, detail drawings, digital graphics to communicate design solutions. | Students will have produced a series of design concept sketches.  Students will have a set of detail drawings for the construction of their balsa glider design solution. | Scaffold support to students and groups. Maintain ongoing feedback to elicit strengthened and varying designs. |
| **Weekly reflection** | **Students**  Complete weekly reflection by identifying and evaluating new knowledge or skills considering previous knowledge. | Students answer reflective questions, for example:   * What did I learn about lift and flight this week? * Why did I enjoy doing this? * Was I successful in my learning this week? | Procedural recount to be prepared on paper or digitally, including speech to text or voice recording. |
| **Week 4 – prototype and build**  **ST5-1, ST5-2, ST5-3, ST5-4**  **Students:**   * describe how different aeronautical craft produce thrust * use technologies to produce aeronautical engineering models and/or prototypes, for example * computer-aided design (CAD) software, computer- aided manufacturing (CAM), 3D printers, laser cutters * develop practical skills using appropriate tools for the purposes of producing aeronautical engineering models or prototypes, - marking out, cutting, joining and finishing. | **Teacher**  Describe how typical a fixed wing aircraft produces thrust using the following technologies:   * propeller * turboprop * jet * turbofan.   Describe how the technology works.  Discuss how the balsa glider is going to be powered. For example, using:   * electric motor * rubber band * gravity.   Provide students with extra materials to modify standard balsa glider to be either high or low lift variants.  Demonstrate safe flight of balsa gliders to class.  **Extension (optional)**  Revise the safe use and operation of computer-aided manufacturing equipment.  **Students**  **Complete any required safety tests for required equipment.**  Decide upon power source for their balsa glider design.  Working in teams, produce a prototype plane design by modifying the base balsa glider design produced in week 3.  Record and test each modified design solution to be added to the engineering report.  **Extension**  Students adapt or redesign their balsa gliders for a new power source. | Students can describe different power sources for typical fixed wing aircraft.  Students safely use tools and technologies to produce prototypes.  Students demonstrate practical skills using appropriate tools to produce high quality models.  Students record their findings from testing in their engineering report. | Procedural recount to be prepared on paper or digitally, including speech to text or voice recording.  Students are supported to allocate roles within groups to align to student interests and strengths. |
| **Weekly reflection** | **Students**  Complete weekly reflection by identifying and evaluating new knowledge or skills considering previous knowledge. | Students answer reflective questions, for example:   * What did I learn about this week? * Why did I enjoy doing this? | Procedural recount to be prepared on paper or digitally, including speech to text or voice recording. |
| **Week 5 – evaluate, test, iterate**  **ST5-2, ST5-3, ST5-6, ST5-9**  **Students:**   * conduct, record and analyse accurate, repeated measurements using data loggers to test aeronautical engineering models * apply fundamental mathematical and statistical techniques, for example * weight and mass, speed, acceleration * mean, mode, median, standard deviation * describe and utilise technologies used in aeronautical engineering design and testing, for example * wind tunnels, smoke tunnels. | **Teacher**  Demonstrate the use of data logging techniques to be applied to the balsa gliders.  Describe how to conduct accurate and repeated measurements.  Demonstrate how to use the statistical analysis tools in Microsoft Excel.  Discuss how wind and smoke tunnels are used to test the aerodynamics of aircraft.  **Extension**  Demonstrate the use of the wind/smoke tunnel.  **Students**  Take multiple measurements in the testing and evaluation of their designs. Including:   * the weight force and mass of each design * the average speed * the average height.   Use the average function in Microsoft Excel to analyse testing data.  Students to create multiple iterations of their design solutions based on testing results.  **Extension**  Using the schools wind/smoke tunnel record the airflow over the foil. | Students conduct several accurate and repeatable measurements whilst testing design concepts.  Use spreadsheets and statistical techniques to analyse the performance of the balsa plane designs.  Students can identify wind and smoke tunnels are used in the design and testing of aircraft. | Support students on how to efficiently use technology to record and analyse data. |
| **Communicate and technologies**  **ST5-6, ST5-8, ST5-9**  **Students:**   * demonstrate innovation and entrepreneurial activity and communicate solutions to problems involving aeronautical engineering * utilise communication techniques to demonstrate design process developed solutions to aeronautical engineering problems * develop an understanding of aeronautical engineering and the aerospace industry * describe technologies used in aeronautical engineering, for example * propulsion, instrumentation, avionics, composites, fly-by-wire. | **Teacher**  Review previous engineering reports and the [engineering report guide [PDF 1.57MB]](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-writing-engineering-reports-teachers-guide.docx). Select appropriate components of engineering report for students to complete.  **Students**  Complete a scaffolded engineering report based on the paper plane or balsa glider design challenges. | Students complete an engineering report in the recommended format.  Students detail analysis of their paper plane and balsa glider designs.  Students will demonstrate high-level communication skills in the completion of an engineering report.  Students can demonstrate how they have been innovative in designing solutions to aerospace problems.  Students will demonstrate an understanding of the aerospace industry and the nature and pathways in the industry through the completion of an engineering report.  Students describe emerging technologies in the aeronautical engineering fields in the completion of the engineering report. | Provide engineering report template to scaffold important aspects. |
| **Weekly reflection** | **Students**  Complete weekly reflection by identifying and evaluating new knowledge or skills considering previous knowledge. | Students answer reflective questions, for example:   * What did I learn about this week? * Why did I enjoy doing this? | Procedural recount to be prepared on paper or digitally, including speech to text or voice recording. |

### Week 6

Table 3 – aeronautical engineering week 6 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 6 – rocket design challenge**  **ST5-2, ST5-7, ST5-10**  Students:   * work individually and collaboratively to apply an engineering design process to create solutions to aeronautical engineering design problems. | **Teacher**  Introduce a rocket design challenge. The challenge is to design and test a rocket that will go the longest possible distance.  **Students**  Share what they have discovered and reflect on information and knowledge gained during the topic in respect to design challenges and evaluate resources, and constraints, for example:   * What is the challenge? * What materials or technologies do we have access to? * What are the time constraints? | Students can identify sources of information and explore existing solutions to create new design ideas. | Activate student prior knowledge by asking questions about previous learning relevant to aeronautical engineering.  When students work collaboratively, support them to identify roles within a team that reflect students' strengths and interests. |
| **Historical and traditional Aboriginal perspectives**  **ST5-5**  **Students:**   * outline historical perspectives in aviation that have impacted the aeronautical industry and society * critically evaluate the impact of aviation on society, environment and people’s lives * examine traditional technologies used by Aboriginal and Torres Strait Islander peoples to solve problems * describe the contributions that aviation professionals make to society. | **Teacher**  Present [The History of Space Exploration: a Timeline (16:03)](https://www.youtube.com/watch?v=3JuKR7jf46o).  Introduce traditional perspectives on how Aboriginal and Torres Strait Islander peoples were the first astronomers.  Present [65,000 yrs – the great history of Australian Aboriginal astronomy (11:40)](https://www.youtube.com/watch?v=mYr7ZCn04eA).  **Teacher and students**  Class discussion on the impact of the space industry on society, the environment and on people’s lives. Divide the class and facilitate a student debate on the positive and negative impacts of the space industry.  Dividing the class, students debate the positive and negative impacts.  Create a [mind map](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/542) to record ideas.  Investigate and make argument for or against the viability of electric planes.  **Students**  Create a timeline showing the most significant historical developments in the space industry.  Investigate and record the contributions aerospace professionals have made to society.  Investigate opportunities for students to be involved in the Australian space industry. | Timeline of the space industry, demonstrating students understanding of key historical events that have impacted the aerospace industry and society in general.  Students to be able to demonstrate both the positive and negative aspects of the development of the modern space industry and its effects on society, the environment and people’s lives.  Students demonstrate an understanding of the different opportunities that exist to join the Australian space industry.  Students can identify traditional astronomical techniques used by Aboriginal and Torres Strait Islander peoples. | Use closed captions when viewing video to assist understanding and vocabulary building. Pause video to assess student understanding at appropriate points.  Provide stimulus to generate discussion – samples of positive and negative impacts of the space industry. |
| **Aerodynamics of rockets**  **ST5-2, ST5-5**  Students:   * explain a range of fundamental aerodynamic principles related to flight * explore concepts of fluids mechanics related to aeronautical engineering. | **Teacher**  Revise the 4 basic forces within aerodynamics, lift, thrust, drag and weight as they apply to a rocket.  Demonstrate a successfully completed rocket. Explain how aerodynamic concepts have been used to ensure its success.  **Students**  Create diagrams explaining how lift, thrust, drag and weight are applied to rocket design.  Experiment with the forces of aerodynamics using a simulation to complete the [rocket launch challenge](https://www.sciencelearn.org.nz/resources/407-launch-simulator-challenge). | Students demonstrate a thorough understanding of the 4 aerodynamic forces as they apply to rocket design.  Students demonstrate the need to balance the aerodynamic forces by the successful completion of the rocket launch challenge. | (Add planned adjustments and enhancements, and registration. Ideas for appropriate adjustments and enhancements have been included). |
| **Weekly reflection** | **Students**  Complete weekly reflection by identifying and evaluating new knowledge or skills. | Students answer reflective questions, for example:   * What did I learn about designing this week? * What prepared me to learn best? * How could I have learnt more? * What should I do next week to learn better? | Procedural recount to be prepared on paper or digitally, including speech to text or voice recording. |

### Weeks 7 and 8

Table 4 – aeronautical engineering weeks 7 and 8 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 7 – rocket investigations**  **Define and identify**  **ST5-2, ST5-5**  Students:   * design and build a system to solve a real-world aeronautical engineering or aerospace problem * work individually and collaboratively to apply an engineering design process to create solutions to aeronautical engineering design problems. | **Teacher**  **Select bottle rocket or stomp rocket project. If time permits, class could do both projects.**  **Define the problem and identify the constraints.**  **Demonstrate how to construct a standard bottle rocket or stomp rocket (as shown in video 1 of** [Stomp Rockets (5:37)](https://www.jpl.nasa.gov/edu/teach/activity/stomp-rockets/)**).**  **Class discussion**  **Class to compare the different design constraint concepts presented in the bottle rocket challenge video, for example:**   * **How to make your bottle rocket fly straight?** * **How to keep your bottle rocket’s mass low?** * **How to make your bottle rocket aerodynamic?** * **What are some of the operational requirements for the bottle rocket?**   **Students**  **Construct a cardboard rocket model similar to the one shown in video 2 of** [Stomp Rockets (5:02)](https://www.jpl.nasa.gov/edu/teach/activity/stomp-rockets/) **and complete the rocket science experiment. Determine the centre of pressure and centre mass required for stable flight.** | Students demonstrate deep understanding of how to construct a rocket that will fly straight and will achieve a long distance in flight.  Students produce rockets that demonstrate a fundamental understanding of the relationship between centre of pressure and centre of mass. | (Add planned adjustments and enhancements, and registration. Ideas for appropriate adjustments and enhancements have been included). |
| **Computer-aided design and manufacture**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-5, ST5-6, ST5-8**  **Students:**   * use technologies to produce aeronautical engineering models and/or prototypes, – computer-aided design software, computer-aided manufacturing, 3D printers, laser cutters. | **Teacher**  Revise the use of a CAD software package previously used by the class.  Demonstrate how 3D printed components can be used to enhance rocket construction.  **Extension (optional)**  Demonstrate the use of [Adobe Illustrator](https://app.education.nsw.gov.au/digital-learning-selector/LearningTool/Card/43) to produce drawings for laser cut components.  Demonstrate the safe use of a vinyl cutter. | Students demonstrate the use of CAD in the design process.  Students produce CAD drawings of their chosen design solutions.  Students utilise advanced manufacturing techniques to produce high quality high procession parts for design solutions. | (Add planned adjustments and enhancements, and registration. Ideas for appropriate adjustments and enhancements have been included). |
| **Bottle rocket design**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-8**  **Students:**   * design and build a system to solve a real-world aeronautical engineering or aerospace problem * work individually and collaboratively to apply an engineering design process to create solutions to aeronautical engineering design problems. | **Teacher**  **Provide instructions to students on the design phase of the engineering design process.**  **Present** [How to draw and design a Bottle Water Rocket (7:51)](https://www.youtube.com/watch?v=1va4XphKHFs)**.**  **Students**  **Research rocket fin designs and brainstorm different design options.**  **Draw or use computer software to design thumbnail sketches of 5 different fin shapes.**  **Design an annotate at least 4 different rockets designs.**  **Calculate the surface area of fin shapes (triangle, quadrant, rhombus and trapezium).**  **Evaluate each design idea using a** [PMI chart](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/551) **and select a final solution.**  **Produce an isometric sketch of final rocket design based off video.**  **Extension**  **Students produce a rendered 3D CAD drawing of their final design solution.** | Students individually or in groups have constructed a physical prototype based on their CAD drawing or design sketch. | Actively assess student progress and assist where appropriate. |
| **Prototype build**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-8**  **Students:**   * use technologies to produce aeronautical engineering models and/or prototypes, for example * computer-aided design software, computer-aided manufacturing, 3D printers, laser cutters * develop practical skills using appropriate tools for the purposes of producing aeronautical engineering models or prototypes, for example * marking out, cutting, joining and finishing. | **Teacher**  **Organise for students to collect materials for rockets, for example:**   * **1.25 L PET bottles** * **corriboard.**   Organise and facilitate access to workshop which may include:   * marking out, cutting, and joining tools * 3D printing facilities * laser cutting facilities * vacuum moulding machine.   **Demonstrate the safe use of tools and machinery required to build the rocket and conduct any required safety testing.**  **Students**  **Complete any required safety tests for required equipment.**  **Use their design drawings, materials, and equipment to construct a prototype rocket.**  **Teacher**  **Assist students in fabrication of their design using available resources, for example:**   * 3D printing * laser cutting * hand tools * machines * vacuum forming machine.   **Students**  Use CAD and/or CAM technologies to produce 3D printed components or laser cut objects such as fins.  **Extension**  Use vacuum forming machine – teacher to demonstrate its use to produce nose cones.  Students to experiment with different nose cone designs. | Students have constructed a physical prototype based on their CAD drawing or design sketches. | Actively assess student progress and assist where appropriate. |
| **Evaluate and test**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-8**  **Students:**   * conduct, record and analyse accurate, repeated measurements using data loggers to test aeronautical engineering models * apply fundamental mathematical and statistical techniques, for example * weight and mass, speed, acceleration * mean, mode, median, standard deviation * describe and utilise technologies used in aeronautical engineering design and testing. | **Teacher**  Demonstrate the use and operation of an altimeter device.  Demonstrate the safe operation of the rocket launch system.  Demonstrates motion tracking using video footage to analyse flight path.  Demonstrate how to make a clinometer and demonstrate its use. Access instructions [Making Maths: Clinometer](https://nrich.maths.org/make-a-clinometer) on the University of Cambridge’s NRICH website.  **Students**  Under direct teacher supervision, launch rockets, documenting key measurements including distance.  Students create a clinometer and use it to estimate height of their rocket. Students experiment with different variables. For example:   * mass * water pressure * fin location * angle of release.   Plot the rocket’s motion using the video footage, then use trial and error to determine the quadratic equation for the curve, assuming the axis of symmetry is at x = 0 (start with a simple quadratic, then translate up and down, and change the width by adjusting the parameters).  Students record all statistical information for each launch.  Students conduct other testing such as wind/smoke tunnel testing. | Students demonstrate a deep understanding of the different launch parameters (variables) and their effect of bottle rocket performance.  Students can utilise basic statistical techniques to analyse rocket performance.  Students utilise flight data recorded from an altimeter to evaluate rocket performance. | Actively assess student progress and assist where appropriate. |
| **Weekly reflection** | **Students**  Complete weekly reflection by identifying and evaluating new knowledge or skills | Students answer reflective questions, for example:   * What did I learn about force and motion this week? | Modelling of the reflective process may assist with this task. |

### Weeks 9 and 10

Table 5 – aeronautical engineering weeks 9 and 10 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 9 – evaluate**  **ST5-1, ST5-1, ST5-3, ST5-4, ST5-9**  Students:   * work individually and collaboratively to apply an engineering design process to create solutions to aeronautical engineering design problems. | **Teacher**  Review engineering design process evaluation questions with students, for example:   * What revisions or improvements can be made to the design? * Have safety requirements been met?   **Students**  Complete a critical evaluation of their prototype or partially completed prototype. | Students document their evaluation on how successful their prototype rocket performed.  Students can answer evaluation questions, for example:   * Can your design choices be justified? * What was discovered from the testing and experimentation of the solution? * What can be improved on the design solution? * Is there more experimentation and testing required? | Provide worksheet, in PDF format for students who need digital versions, with evaluation prompts or template to scaffold evaluation.  Provide evaluation example to demonstrate the process. |
| **Iterate**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-8**  **Students:**   * use technologies to produce aeronautical engineering models and/or prototypes, for example * computer-aided design software, computer-aided manufacturing, 3D printers, laser cutters * develop practical skills using appropriate tools for the purposes of producing aeronautical engineering models or prototypes, for example * marking out, cutting, joining and finishing. | **Teacher**  Review the role of iteration in the engineering design process.  Review engineering design process iterate questions with students, for example:   * How can the solution be further improved? * If you decide to make revisions, what will it look like?   Organise and facilitate students access to workshop.  **Students**  Complete a critical evaluation of their prototype.  Use critical evaluation to make modifications of bottle rocket design.  **Use updated design drawings, materials and equipment to modify their final prototype bottle rocket design.** | Students document their evaluation on how successful their prototype communicates their design solution.  Students demonstrate capacity to use evaluation to inform adaptation and iteration of their design. | Provide worksheet in PDF format for students who need digital versions, with possible iteration questions or template to scaffold potential changes.  Provide iteration example to demonstrate planning for changes. |
| **Further evaluation and testing**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-8**  **Students:**   * conduct, record and analyse accurate, repeated measurements using data loggers to test aeronautical engineering models. | **Teacher**  Review the safe operation of the rocket launch system.  Teacher needs to complete a risk assessment using tools such as RiskAssess.  **Students**  Under direct teacher supervision, launch rockets, documenting key measurements including distance.  Students have 3 launch attempts each and the rockets are to be assessed for distance, altitude and accuracy.  **Extension**  Students add a simple recovery parachute system to their bottle rocket for vertical launches. | Students demonstrate capacity to communicate adaptation and iteration of their design. | Use scaffolding and modelling to reinforce understanding of instructions. |
| **Weekly reflection** | **Students**  Complete a final reflection by identifying and evaluating new knowledge or skills that were learnt throughout the unit. | Students answer reflective questions, for example:   * What did I learn about aeronautical engineering throughout this topic? * What prepared me to learn best? * How could I have learnt more? * What should I do next week to learn better? * What new skills have I developed? | Procedural recount to be prepared on paper or digitally, including speech to text or voice recording. |

## Reflection and evaluation

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

## Additional information

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

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

### Assessment for learning

Possible formative assessment strategies that could be included:

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

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

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

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

### Differentiation

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

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

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

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

### About this resource

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

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

**Creation date**: 15 November 2022

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**Evidence Base**:

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

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

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

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

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

## References

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

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

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AITSL (Australian Institute for Teaching and School Leadership (2017) ‘[Feedback Factsheet](https://www.aitsl.edu.au/teach/improve-practice/feedback#:~:text=FEEDBACK-,Factsheet,-A%20quick%20guide)’, AITSL, accessed 14 February 2023.

American History Geek (20 December 2020) [‘History of Aviation Explained’ [video]](https://www.youtube.com/watch?v=VAd3z06N_mE), *American History Geek,* YouTube, accessed 13 February 2023.

ASTC (Association of Science and Technology Centers) Science World Society (2023) ‘[Balloon Hovercraft](https://www.scienceworld.ca/resource/balloon-hovercraft/)’, Resources, Science World website, accessed 14 February 2023.

Condé Nast (2021) ['Aerodynamics Explained by a World Record Paper Airplane Designer | Level Up | WIRED' [video]](https://www.youtube.com/watch?v=3KqjRPV9_PY), *Wired,* YouTube, accessed 14 February 2023.

Designability Group Pty Ltd (2021) [*Projects*](https://powerstem.com.au/projects/), PowerStem Projects website*,* accessed 14 February 2023.

Florek S (2018) ‘[The Boomerang is Curved to Fly](https://australian.museum/learn/cultures/atsi-collection/boomerangs/the-boomerang-is-curved-to-fly/)’, Boomerangs, Australian Museum Website, accessed 14 February 2023.

Florek S (2021) ‘[The returning Boomerang: how it flies](https://australian.museum/learn/cultures/atsi-collection/boomerangs/the-returning-boomerang-how-it-flies/)’, Boomerangs, Australian Museum Website, accessed 14 February 2023.

Florek S (2021) ‘[Why a Boomerang flies’](https://australian.museum/learn/cultures/atsi-collection/boomerangs/why-a-boomerang-flies/), Boomerangs, Australian Museum Website, accessed 14 February 2023.

Modelflight (2023) [*Guillow’s Mini Model V-Tail Laser Cut Rubber Band Powered Kit*](https://www.modelflight.com.au/guillow-s-mini-model-v-tail-laser-cut-rubber-band-powered-kit.html), Modelflight website, accessed 14 February 2023.

NESA (NSW Education Standards Authority) ‘[Proficient Teacher: Standard descriptors](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher)’, *The Standards*, NESA, accessed 14 February 2023.

[*Nurturing Wonder and Igniting Passion, designs for a new school curriculum: NSW Curriculum Review* [PDF 1.12MB]](https://nswcurriculumreform.nesa.nsw.edu.au/pdfs/phase-3/final-report/NSW_Curriculum_Review_Final_Report.pdf), © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2020, accessed 14 February 2023.

Oak Ridge Institute for Science and Education (2020) [*Floating Ping Pong Ball* [PDF 364KB]](https://orise.orau.gov/resources/k12/documents/lesson-plans/floating-ping-pong-ball.pdf), Oak Ridge Institute for Science and Education, accessed 14 February 2023.

PPO (16 December 2018) [‘How To Make 5 EASY Paper Airplanes that FLY FAR’ [video]](https://www.youtube.com/watch?v=54noZe-0B1c), *PPO*, YouTube, accessed 14 February 2023.

PwC (PricewaterhouseCoopers) Australia (2022) ‘[A smart move](https://www.pwc.com.au/publications/a-smart-move.html)’, PwC Australia, accessed 14 February 2023.

Refraction Media (n.d.) [*Careers with STEM*](https://careerswithstem.com.au/) [website],accessed 14 February 2023.

Science Learning Hub – Pokapū Akoranga Pūtaiao, University of Waikato (2011) [Rocket Launch Challenge](https://www.sciencelearn.org.nz/resources/407-launch-simulator-challenge), Science Learning Hub – Pokapū Akoranga Pūtaia website*,* accessed 14 February 2023.

Space Junkies (6 July 2021) ['The History of Space Exploration: a Timeline' [video]](https://www.youtube.com/watch?v=3JuKR7jf46o), *Space Junkies,* YouTube, accessed 14 February 2023.

Splat3D Design for STEAM (25 March 2019) ['How to draw and design a Bottle Water Rocket – St Aloysius STEM Challenge' [video]](https://www.youtube.com/watch?v=1va4XphKHFs), *Splat,* YouTube, accessed 14 February 2023.

State of New South Wales (Department of Education) (2022) ‘[Careers with STEM](https://education.nsw.gov.au/teaching-and-learning/curriculum/stem/stem-curriculum-resources/careers-with-stem)’, *STEM curriculum resources,* NSW Department of Education website,accessed 14 February 2023.

State of New South Wales (Department of Education) (2021) [*Digital Learning Selector*](https://app.education.nsw.gov.au/digital-learning-selector/), NSW Department of Education website,accessed 14 February 2023.

State of New South Wales (Department of Education) (2021) ‘[iSTEM Engineering Design Process](https://education.nsw.gov.au/teaching-and-learning/curriculum/department-approved-courses/istem#/asset4)’, NSW Department of Education, accessed 14 February 2023.

State of New South Wales (Department of Education) (2022) [*iSTEM engineering design process: A guide for teachers* [DOC 1.09MB]](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-engineering-design-process.docx) NSW Department of Education,accessed 14 February 2023.

State of New South Wales (Department of Education) (2021) [*iSTEM – Writing engineering reports: Teacher guide*](https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/curriculum/elective-courses/media/documents/istem-s5-writing-engineering-reports-teachers-guide.docx)[DOC 1.57MB] NSW Department of Education,accessed 14 February 2023

State of New South Wales (Department of Education) and CESE (Centre for Education Statistics and Evaluation) (2020a) ‘[What works best: 2020 update](https://education.nsw.gov.au/about-us/educational-data/cese/publications/research-reports/what-works-best-2020-update)’, CESE, NSW Department of Education, accessed 14 February 2023.

State of New South Wales (Department of Education) and CESE (Centre for Education Statistics and Evaluation) (2020b) ‘[What works best in practice](https://education.nsw.gov.au/about-us/educational-data/cese/publications/practical-guides-for-educators-/what-works-best-in-practice)’, CESE, NSW Department of Education, accessed 14 February 2023.

State of New South Wales Department of Premier and Cabinet (2022) ‘[The NSW Industry Development Framework](https://www.investment.nsw.gov.au/living-working-and-business/nsw-industry-development-framework/)’, Living, working and business, Investment NSW website, accessed 14 February 2023.

Tassel L (16 Jan 2019) [‘Why strive for Industry 4.0’](https://www.weforum.org/agenda/2019/01/why-companies-should-strive-for-industry-4-0/), *World Economic Forum agenda articles*, accessed 14 February 2023.

TED Conferences, LLC (8 May 2019[) ‘65,000 yrs – the great history of Australian Aboriginal Astronomy | Kirsten Banks | TEDxYouth@Sydney’ [video]](https://www.youtube.com/watch?v=mYr7ZCn04eA), *TEDx Talks*, YouTube, accessed 14 February 2023.

The President and Fellows of Harvard College (7 June 2017) [‘Coanda Effect’ [video]](https://www.youtube.com/watch?v=NvzXKZNJ7ZU), *Harvard Natural Sciences Lecture Demonstrations*, YouTube, accessed 14 February 2023.

Tutt C (2021) The First Scientists: Deadly Inventions and Innovations from Australia's First Peoples (Douglas B, illus.), Hardie Grant Explore, Australia.

University of Cambridge (Faculty of Mathematics) (1997–2023) [*Making Maths: Clinometer*](https://nrich.maths.org/make-a-clinometer), NRICH website, accessed 14 February 2023.

Vector Pilot Prep (7 December 2018) ['Lift According to Newtons 3rd Law, Explained' [video],](https://www.youtube.com/watch?v=ERF9NMka5Ic) *Vector Pilot Prep,* YouTube, accessed 14 February 2023.

Zgelfer (3 April 2016) ['Part 1 – Lift and Bernoulli's Principle' [video]](https://www.youtube.com/watch?v=HmDYbnGnhpA), *Zgelfer*, YouTube, accessed 14 February 2023.