# iSTEM – STEM fundamentals



Contents

[STEM fundamentals 2](#_Toc126677091)

[Duration of learning 2](#_Toc126677092)

[Outcomes 2](#_Toc126677093)

[Rationale 4](#_Toc126677094)

[Aim 5](#_Toc126677095)

[Purpose and audience 5](#_Toc126677096)

[When and how to use this document 5](#_Toc126677097)

[Learning sequences 6](#_Toc126677098)

[Weeks 1 and 2 7](#_Toc126677099)

[Weeks 3 and 4 14](#_Toc126677100)

[Weeks 5 and 6 22](#_Toc126677101)

[Weeks 7 and 8 28](#_Toc126677102)

[Weeks 9 and 10 36](#_Toc126677103)

[Reflection and evaluation 44](#_Toc126677104)

[Additional information 45](#_Toc126677105)

[Assessment for learning 45](#_Toc126677106)

[Differentiation 46](#_Toc126677107)

[About this resource 47](#_Toc126677108)

[References 50](#_Toc126677109)

## STEM fundamentals

STEM fundamentals develop knowledge, skills and understanding of essential STEM principles and processes. Students engage with engineering design processes to solve a range of problems. They develop fundamental skills required to complete other elective topics which form the basis of this course.

To satisfy the requirements of this core topic, students must utilise iterative engineering design processes to undertake a range of problem-solving exercises, collaborative tasks and inquiry-based learning activities that occupy the majority of the time.

### Duration of learning

Indicative time – 25 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. Consult the course document for further details on sequencing core, elective and specialised topics.

## Learning sequences

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

### Weeks 1 and 2

Table – STEM fundamentals weeks 1 and 2 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 1 – Introduction**  **ST5-3, ST5-10**  Students:   * investigate how STEM principles and processes are used to solve real-world problems in local, national, and international contexts * describe components of the engineering design process. | **Teacher**  Introduce course and STEM fundamentals topic.  Outline course structure and overview themes contained within the course.  Present examples of complex problems facing the world and discuss the role of United Nations Sustainability Goals in responding to these issues.  Introduce the engineering design process.  **Students**  Describe real-world problems from a local, national, or international context and identify the relevant United Nations Sustainability Goals that applies. | Students can describe real-world problems from a range of contexts and identify the relevant United Nations Sustainability Goals which seek to address these problems.  Students can describe the cyclic nature of an engineering design process.  Students can identify that an engineering design process can be used to solve problems. | (Add adjustments and registration) |
| **ST5-5, ST5-10**  Students:   * investigate how STEM principles and processes are used to solve real-world problems in local, national, and international contexts. * investigate assistive technologies used by people with a disability * utilise a variety of research techniques. | **Teacher**  Examine positive contributions STEM professionals have made toward the world in which we live, for example, assistive technologies.  Examine some assistive technologies and scaffold the benefits and costs of each solution.  **Student**  Select and explore an assistive technology and discuss the impact this solution has on users. | Students have documented their research and discussion on the impact of assistive technologies through their weekly reflection task.  Students link assistive technologies to the [United Nations Sustainability Goals.](https://sdgs.un.org/goals) | (Add adjustments and registration) |
| **ST5-5**   * investigate traditional technologies used by Aboriginal and Torres Strait Islander peoples. | **Teacher**  Examine a traditional technology used by Aboriginal and Torres Strait Islander peoples and identify the STEM principles addressed by the innovation.  Discuss any impact the innovation has had on users.  **Student**  Select and explore a traditional technology used by Aboriginal and Torres Strait Islander peoples and discuss the impact this innovation had on users and influences it has had on modern innovations. | Students to be able to recall traditional technologies used by Aboriginal and Torres Strait Islander peoples.  Students will be able to describe how a traditional innovation has met a user's need. | (Add adjustments and registration) |
| **Weekly reflection** | **Teacher**  Explain the purpose of a weeklyreflection.  Demonstrate how to complete a weekly reflection using a procedural recount text type.  **Student**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflection using school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount text type.  Students will demonstrate the impact of these learning events or activities by making judgments about what has happened and what they still need to understand. | Modelling or providing a template of the reflective process may assist with the metacognitive (thinking about thinking) aspects of this task.  Procedural recount to be prepared on paper or digitally, including speech-to-text. |
| **Week 2 – Define and identify**  **ST5-1**  Students:   * describe components of an engineering design process * investigate how STEM principles and processes are used to solve real-world problems in local, national, and international contexts * use project management techniques in the completion of projects. | **Teacher**  Explain the role of the **define** and **identify** stages in the engineering design process.  Describe the individual components of the engineering design process.  Outline the key components of the engineering design process, for example, define, identify, brainstorm, design, prototype, evaluate, iterate and communicate.  Describe basic project management tools, for example, time or action plans, finance plans, materials lists and resource lists.  **Student**  Discuss how management tools can be used in the design process. | Students will be able to recall different components of the engineering design process.  Students can describe basic concepts of project management in relation to problem-solving activities. | Discussion facilitated using augmentative communication device if necessary to support communication with the group. |
| **ST5-1, ST5-3, ST5-4, ST5-5, ST5-6**  Students:   * undertake a range of activities that highlight STEM principles and processes * applies engineering design processes to address real-world STEM-based problems * work individually and collaboratively, applying engineering design processes to completion of real-world problems * define real-world problems and/or needs. | **Teacher**  Present structured design challenge for students to complete explaining where stages of the challenge link to the engineering design process, for example [Marshmallow challenge](https://www.marshmallowchallenge.com/) and [STEM Olympiad challenges.](https://education.nsw.gov.au/teaching-and-learning/curriculum/stem/stem-curriculum-resources/stem-olympiad)  Scaffold the method of documenting the design processes.  **Student**  Work individually or in groups to complete a design challenge.  Evaluate the effectiveness of working as an individual or as a group. | Students have documented their design process and resulting product.  Students can describe the processes they undertook and provide reasoning for the choices they made.  Students evaluate their use of the design processes.  Students may have worked successfully as individuals or as a group. |  |
| **Weekly reflection** | **Student**  Complete weekly reflection using the following steps:   * identify tasks undertaken, new knowledge, understanding or skills * evaluate new knowledge, understanding or skills in the light of previous knowledge | Students will be able to record their key learning events or activities using a procedural recount text type.  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 recount to be prepared on paper or digitally, including speech to text. |

### Weeks 3 and 4

Table – STEM fundamentals weeks 3 and 4 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 3 – Brainstorm**  **ST5-1, ST5-4**  Students:   * undertake a range of activities that highlight STEM principles and processes * develop ideas and communicate solutions * develop and evaluate creative, innovative, and enterprising design ideas and solutions * work individually and collaboratively, applying engineering design processes to completion of real-world problems. | **Teacher**  Explain the role of brainstorming in the engineering design process.  Identify brainstorming as a step of the engineering design process and explains its role in ideation.  Introduce the [STEM Olympiad](https://education.nsw.gov.au/teaching-and-learning/curriculum/stem/stem-curriculum-resources/stem-olympiad) ideation warm up activity, using the [Idea Machine](https://theideamachine.org/).  Introduce mind mapping as a tool for brainstorming.  Present an Idea Machine problem for the class to solve.  **Student**  Participate in group work to ideate solutions to the Idea Machine problems.  Choose the best solution from their group using a process such as sticky dot voting.  Present their solutions to the class.  Choose the best solution from the class using a process such as sticky dot voting. | Students have documented individual solutions to the class ideas machine problem.  Students have presented a group solution to the class ideas machine problem. | Brainstorming facilitated using augmentative communication device if necessary to support communication with the group.  Teacher to consider accessibility options when using the [Idea Machine](https://theideamachine.org/) website. |
| **ST5-1, ST5-2, ST5-4, ST5-6, ST5-9**  Students:   * identify and use a range of problem-solving strategies in the development of practical solutions * demonstrate basic 2D and 3D drawing techniques * develop and evaluate creative, innovative, and enterprising design ideas and solutions * work individually and collaboratively, applying engineering design processes to completion of real-world problems * undertake a range of activities that highlight STEM principles and processes * take and record accurate, repeated measurements * define real-world problems and/or needs. | **Teacher**  Introduce a [STEM Olympiad](https://education.nsw.gov.au/teaching-and-learning/curriculum/stem/stem-curriculum-resources/stem-olympiad) challenge (or equivalent) for individual completion and unpacks with the class, including defining the success criteria.  Provide materials and resources required for the challenge.  Record the results of solution testing against success criteria for data analysis at a later stage.  **Student**  Create design ideas for possible solutions to the challenge.  Individually use the supplied materials to complete the challenge based on a selected design sketch.  Test the design solution against the success criteria.  Reflect on the success of their solution to the challenge. | Students have documented design solution sketches.  Students have constructed a physical design solution that resembles a design sketch.  Students document the results of testing the design solution against success criteria. | Students may document design solutions using other modes rather than a sketch. |
| **ST5-1, ST5-4, ST5-8**  Students:   * undertake a range of activities that highlight STEM principles and processes * work individually and collaboratively, applying engineering design processes to completion of real-world problems * investigate a range of external STEM initiatives, gaining skills, knowledge and understanding of authentic, real-world problem-solving opportunities * develop ideas and communicate solutions * document and communicate design solutions * develop and evaluate creative, innovative and enterprising design ideas and solutions. | **Teacher**  Introduce SCAMPER as a strategy used for brainstorming with the following steps:   * substitute * combine * adapt * modify * purpose * eliminate * rearrange.   Provide an example of how SCAMPER is used to ideate new ideas for an everyday object, like a student waterbottle.  Present how the SCAMPER task should be recorded and presented.  Present an everyday object/s for students to identify improvements using the SCAMPER ideation process.  Defines what is an ‘elevator pitch’ and provides examples.  **Student**  Apply the SCAMPER ideation process to the given object and records generated ideas.  Present ideas produced by using SCAMPER and gives an elevator pitch of their best idea. | Students record 7 SCAMPER ideas for each everyday object.  Students present an elevator pitch for one selected SCAMPER idea. | (Add adjustments and registration) |
| **ST5-2**   * undertake a range of activities that highlight STEM principles and processes. | **Student**  Complete weekly reflection using school-based template or learning platform. | Students demonstrate critical thinking and skills in using procedural recount text types in the production of a weekly reflection document. | Procedural recount to be prepared on paper or digitally, including speech-to-text. |
| **Week 4 – Brainstorming**  **ST5-1, ST5-2, ST5-4, ST5-6, ST5-9**  Students:   * identify and use a range of problem-solving strategies in the development of practical solutions * demonstrate basic 2D and 3D drawing techniques * develop and evaluate creative, innovative, and enterprising design ideas and solutions * work individually and collaboratively, applying engineering design processes to completion of real-world problems * undertake a range of activities that highlight STEM principles and processes * take and record accurate, repeated measurements * define real-world problems and/or needs. | **Teacher**  Introduce groupwork and describe [characteristics of effective groups](https://www.teaching.unsw.edu.au/group-work).  Describe the roles required to successfully complete STEM challenges.  Introduce a [STEM Olympiad](https://education.nsw.gov.au/teaching-and-learning/curriculum/stem/stem-curriculum-resources/stem-olympiad) challenge (or equivalent) for a group completion and unpack the task, including success criteria.  Provide materials and resources required for the challenge.  Record the results of solution testing against success criteria for data analysis at a later stage.  Repeat this lesson with additional [STEM Olympiad](https://education.nsw.gov.au/teaching-and-learning/curriculum/stem/stem-curriculum-resources/stem-olympiad) challenges (or equivalent) to enable students to explore different group roles and refine groupwork skills.  **Student groups**  Create design ideas for possible solutions to the challenge.  Use the supplied materials to complete the challenge based on a selected design sketch.  Test the design solution against the success criteria.  Reflect on the success of their solution to the challenge.  **Student**  Undertake [STEM Olympiad](https://education.nsw.gov.au/teaching-and-learning/curriculum/stem/stem-curriculum-resources/stem-olympiad) challenges (or equivalent), with students performing a different group role each time. | Students have contributed to and documented group design solution sketches.  As a group, students have constructed a (functional) physical design solution that looks like one of their group’s design sketches.  Students can identify the roles in groups and can describe what makes each role an effective contributor to a group task.  Students demonstrate how they have evaluated the group’s design solution against success criteria with clear and precise statements. | For accessibility students may document design solutions using different modes rather than a sketch. |
| **Weekly reflection** | **Student**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflection using school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount text type.  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 recount to be prepared on paper or digitally, including speech-to-text. |

### Weeks 5 and 6

Table – STEM fundamentals weeks 5 and 6 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 5 – Design**  **ST5-6, ST5-8**  Students:   * demonstrate basic 2D and 3D drawing techniques * develop basic Computer Aided Design (CAD) skills using suitable drawing software * undertake a range of activities that highlight STEM principles and processes * iterate and improve on design solutions using experimentation and testing * document and communicate design solutions * evaluate the benefits of CAD. | **Teacher**  Explain the role of **design** in the engineering design process.  Introduce and demonstrate a range of graphical communication techniques, including:   * third angle orthographic drawing, including front, side and top views and their alignment, dimensioning and title blocks * isometric projection, including 90- and 30-degree guidelines * CAD drawing in an appropriate platform.   Outline the place of graphical communication techniques in the engineering design process.  Discuss the benefits of CAD compared to traditional technical drawing methods.  Introduce scale in design drawing.  **Student**  Evaluate CAD using an appropriate evaluation tool, for example SWOT with the following steps:   * Strengths * Weaknesses * Opportunities * Threats   Produce drawings (to scale) of a selected STEM challenge solution from week 3 or 4. | Students produce a portfolio of drawings of STEM challenge solutions using demonstrated drawing techniques. | Portfolio drawings can be produced using a range of modes, including paper or digital.  Discussion facilitated using augmentative communication device if necessary to support communication with the group. |
| **Weekly reflection** | **Student**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflection using school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount text type.  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 recount to be prepared on paper or digitally, including speech-to-text. |
| **Week 6 – Prototype**  **ST5-1, ST5-3, ST5-4, ST5-6, ST5-8**  Students:   * undertake a range of activities that highlight STEM principles and processes * describe components of an engineering design process * utilise a variety of research techniques * develop ideas and communicate solutions * iterate and improve on design solutions using experimentation and testing * develop and evaluate creative, innovative, and enterprising design ideas and solutions * develop practical model-making and prototyping skills using appropriate tools * work individually and collaboratively, applying engineering design processes to completion of real-world problems * develop and evaluate creative, innovative, and enterprising design ideas and solutions * use technologies to communicate design solutions. | **Teacher**  Explain the role of **prototyping** in the engineering design process.  Introduce physical and digital prototyping and discuss its place in the engineering design process and how it is used in industry.  Induct students in safe ways of working on practical tasks, including any mandated safety testing (if required).  Demonstrate how to safely use a range of tools for prototyping appropriate for the chosen materials.  Identify a STEM challenge from weeks 3 or 4 that can be improved or reimagined from the chosen prototyping material.  Revise how to use an appropriate CAD platform.  **Student**  Create design ideas for a revised solution to the challenge.  Create a simple CAD drawing to scale of the selected solution.  Use the supplied materials to construct a prototype from a CAD drawing.  Test a prototype against the success criteria.  Reflect on the success of their prototype and how successfully it communicates their design solution. | Students have documented design solution sketches.  Students produce a CAD drawing of their chosen solution.  Students have constructed a physical prototype based on their CAD drawing.  Students document the results of testing the design solution against success criteria.  Students document their reflection on how successful their prototype communicates their design solution. | Design solution sketches can be produced using a range of modes, including paper or digital.  Student reflection using a range of modes, including paper, orally or digital. |
| **Weekly reflection** | **Student**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflection using school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount text type.  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 recount to be prepared on paper or digitally, including speech-to-text. |

### Weeks 7 and 8

Table – STEM fundamentals weeks 7 and 8 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 7 – Design**  **ST5-9, ST5-10**  Students:   * apply data science principles to activities/projects * explain the effects of emerging technologies on current and future STEM careers * investigate the nature and scope of work undertaken and the pathways into STEM careers * investigate a range of external STEM initiatives, gaining skills, knowledge and understanding of authentic, real-world problem-solving opportunities. | **Teacher**  Introduce the concept of data science and the importance of collecting, organising, and analysing data in solving problems.  Discuss the current and emerging technologies that are used in data science.  Define elements that will be captured in terms of data items.  Outline issues in collecting data.  Explain why establishing base line data is important.  Discuss the role of a data scientist.  **Student**  Investigate the role of [data scientists](https://careerswithstem.com.au/what-do-data-scientists-do/#gsc.tab=0) using the [Careers with STEM Website](https://careerswithstem.com.au/#gsc.tab=0).  **Extension**  Invite a data scientist to address the class as a virtual incursion. | Students explain the importance of accurate data collection techniques for decision making.  Students explain the impact of accurate data collection, for example its use in weather forecasting.  Students can provide reasons for collecting data and making predictions.  Using case studies on the applications of data logging, students demonstrate understanding and insight into how the use cases build awareness of potentially critical events. Students build awareness of improved decision making in responding to current issues and finding solutions to problems.  Students actively participate in class conversations about STEM careers in data science fields.  Students can describe the role of a data scientist.  Students can describe the pathways into data science careers. | Discussion facilitated using augmentative communication device if necessary to support communication with the group.  Teacher to consider accessibility options when accessing the Careers with STEM website. |
| **ST5-6, ST5-9**  Students:   * explore a variety of technologies which assist in data-gathering and investigation * utilise various digital technologies in developing solutions to STEM-based problem. | **Teacher**  Introduce microcontroller technologies and other hardware to be used and explain safety issues.  Demonstrate the use of microcontrollers, for example:   * Micro:bit * Arduino. | Students can identify key hardware components.  Students can identify safety requirements of each piece of technology to be used. | (Add adjustments and registration) |
| **ST5-6, ST5-8**   * utilise various digital technologies in developing solutions to STEM-based problems * apply coding to create solutions using physical computing and robotics technologies. | **Teacher**  Demonstrate the use of digital coding technologies, for example:   * Microsoft MakeCode * MicroPython.   Explain programming concepts, including:   * control structures * sequence * selection (branching) * repetition (iteration) * relevant data types * text * numbers * Boolean. * functions (as necessary). | Students can identify key features of a program written in the selected general-purpose coding language.  Students can recall the order of stages required for planning a successful data collection and can demonstrate an understanding of the logical reasons for the sequence. | (Add adjustments and registration) |
| **ST5-6, ST5-8**   * utilise various digital technologies in developing solutions to STEM-based problems. * apply coding to create solutions using physical computing and robotics technologies. | **Teacher**  Demonstrate how the coding environment operates and how to upload code to the microcontroller.  **Student**  Learn to use selected coding environment to program microcontrollers to perform some simple tasks which may include:   * blinking LEDs * reading values. | Students can enter instructions or code into the coding environment and successfully upload it onto a microcontroller.  Students can demonstrate success with properly functioning code as intended by the set task.  If the code is not functioning properly, students can work on debugging syntax errors.  If code is functioning, but not as intended, students can correct the code’s logic errors. | (Add adjustments and registration) |
| **ST5-6, ST5-8**   * utilise various digital technologies in developing solutions to STEM-based problems. * apply coding to create solutions using physical computing and robotics technologies. | **Teacher**  Demonstrate additional coding features. | Students can enter instructions or code into the coding environment and successfully upload it onto the microcontroller.  Students can demonstrate success with properly functioning code as intended by the set task.  If the code is not functioning properly, students can work on debugging syntax errors.  If code is functioning, but not as intended, students can correct the code’s logic errors. | (Add adjustments and registration) |
| **Week 8 – Design**  **ST5-9**  Students:   * apply coding to create solutions using physical computing and robotics technologies. | **Teacher**  Demonstrate a pre-assembled datalogger and explain its functions.  Show how to access and view the captured data. | (Insert evidence of learning) | (Add adjustments and registration) |
| **ST5-6, ST5-9**  Students:   * apply data science principles to activities/projects.   **Extension**   * apply fundamental mathematical and statistical techniques. | **Teacher**  Demonstrate how to use a spreadsheet program focussing on entering and/or importing data, organise and manipulate data within columns and rows, clean data and apply necessary formatting, selecting data to generate charts or graphs.  **Student**  Import data into spreadsheet collected from microcontroller.  Organise and/or format data values to allow processing and creating of charts or graphs.  **Extension**  Use basic formulas in a spreadsheet to undertake calculations. | Students produce a spreadsheet for the collation and manipulation of data.  Students can successfully import data into the spreadsheet and format the data to ensure it is readable and useable. | Using the data collected over a longer time period, analyse, and suggest reasons for any discrepancies. |
| **ST5-5**   * undertake a range of activities that highlight STEM principles and processes. | **Teacher**  Lead class discussion on relevant aspects of collected data.  **Student**  Analyse collected data and provide reasons for results, including unusual or erroneous data values. | Students actively participate in classroom discussion about:   * issues collecting data * assessing the reliability and validity of data * the value of data in decision making.   Students can assess the validity of data and subsequently recognise trends. | Class discussion facilitated using augmentative communication device if necessary to support communication with the group. |
| **Weekly reflection** | **Student**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflection using school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount text type.  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. |  |

### Weeks 9 and 10

Table – STEM fundamentals weeks 9 and 10 learning sequence

|  |  |  |  |
| --- | --- | --- | --- |
| Outcomes and content | Teaching and learning | Evidence of learning | Adjustments and registration |
| **Week 9 – Communication**  **ST5-3, ST5-6, ST5-7, ST5-8, ST5-10**  Students:   * describe components of an engineering design process * use project management techniques in the completion of projects * develop and evaluate creative, innovative, and enterprising design ideas and solutions * critically evaluate solutions to problems * document and communicate design solutions * apply fundamental mathematical and statistical techniques. | **Teacher**  Explain the role of communication in the engineering design process.  Introduce an engineering design portfolio or equivalent as a tool for communicating engineering design process steps and outcomes.  **Teacher and students**  Identify key components of an engineering design portfolio that demonstrates the successful development of STEM fundamental skills from this unit, for example brainstorming mindmap, design sketching, orthographic drawing, isometric projection, CAD drawing, procedure or factual recount, calculation of average test results, comparison of results against class average as a graph, evaluation.  **Teacher**  Provide a scaffold for the engineering design portfolio if required.  Revise types of writing and text types required for engineering design portfolio.  **Students**  Compile an engineering design portfolio or equivalent, using evidence produced over thecourse of the STEM fundamentals topic.  Compose a discussion that persuades the audience that they have developed the STEM fundamental skills required to be successful in the course, based on evidence in their engineering design portfolio. | Students complete work on an engineering design portfolio or equivalent.  Students demonstrate an understanding of the use of an engineering design process to solve problems. | (Add adjustments and registration) |
| **Iteration**  **ST5-1, ST5-2, ST5-3, ST5-4, ST5-6, ST5-7, ST5-10**  Students:   * undertake a range of activities that highlight STEM principles and processes * describe components of an engineering design process * develop ideas and communicate solutions * iterate and improve on design solutions using experimentation and testing * use project management techniques in the completion of projects * develop and evaluate creative, innovative, and enterprising design ideas and solutions * critically evaluate solutions to problems * document and communicate design solutions * apply fundamental mathematical and statistical techniques. | **Teacher**  Explain the role of **iteration** in the engineering design process.  Introduce characteristics of effective iteration in the engineering design process and describe its role in completing STEM challenge tasks successfully. Focus on the repetitive nature of iteration in improving ideas and solutions.  Identify a previously completed STEM challenge from weeks 3 or 4 (or alternative) that can be improved through repeated iteration.  Revise groupwork, characteristics of effective groups and the roles required to complete STEM challenge tasks successfully.  Provide materials and resources required for the challenge.  Repeat iteration of one of the selected week 3 or 4 activities, directing students to add improved features.  Describe how to produce a basic Gantt chart to effectively plan a design activity.  Revise fundamental mathematical and statistical techniques to compare measurements taken from challenges.  **Students**  Apply a SWOT analysis to the results of the previously completed STEM challenge.  Iterate a series of improved solutions to the previously completed STEM challenge, using knowledge and skills developed since.  Document each step of the completed engineering design process of the iterated design solution. | Students completed SWOT analysis of a previous STEM challenge solution.  As a group, students have constructed a (functional) physical design solution that have improvements over the previous.  Students document how they have applied iteration to the group’s design solution. | (Add adjustments and registration) |
| **Week 10 – Evaluation**  **ST5-2, ST5-3, ST5-6**  Students:   * critically evaluate solutions to problems * develop and evaluate creative, innovative, and enterprising design ideas and solutions * document and communicate design solutions. | **Teacher**  Explain the role of **evaluation** in the engineering design process.  **Student**  Complete a critical evaluation of the design solution using a number of tools, for example:   * SWOT * Questionnaires * Surveys * Observation. | Students able to critically evaluate a design solution against a set of quality criteria.  Students complete a discussion explaining their successful STEM fundamentals development. | Discussion facilitated using augmentative communication device if necessary to support communication with the group. |
| **ST5-10**  Students:   * investigate the nature and scope of work undertaken and the pathways into STEM careers. | **Teacher**  Discuss how STEM professionals utilise the same problem-solving skills, developed in this unit in their role.  Discuss the broad range of STEM professions and the different pathways in which a student could become a STEM professional.  Navigate students through the [Careers with STEM website](https://careerswithstem.com.au/).  **Student**  Investigate different STEM roles that may be of interest and the pathways required. | (Insert evidence of learning) | (Add adjustments and registration) |
| **Extension (Optional)**  **ST5-10**   * **investigate a range of external STEM initiatives, gaining skills, knowledge and understanding of authentic, real-world problem-solving opportunities.** | **Extension (Optional)**  **Teacher**  Explore opportunities to allow students to communicate their design ideas to the broader education community. For example, external competitions,open days, guest judges, school newsletters.  **Student**  Display design ideas to the broader educational community. | **Students are able to communicate their design ideas to a variety of audiences.** | (Add adjustments and registration) |
| **Weekly reflection** | **Student**  Assess what they know, what they need to know, and how they might bridge any gap in understanding that exists.  Complete weekly reflection using school-based template or learning platform. | Students will be able to record their key learning events or activities using a procedural recount text type.  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. | (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 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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