YEAR 9 ISTEM PROGRAM

2020

Abstract

The following program was developed as a collaboration with the STEM Industry School Partnerships (SISP) program and TAS teachers from Cessnock High School. It has been designed to meet the localised needs of the school and as an Academy of STEM Excellence.

Term 1 Aeronaut – 9 iSTEM – Stage 5 program

Summary

Aerodynamics is the study of air flow around solid objects in reference to the design and function of many forms of transportation. This unit introduces students to the science, technology, engineering and mathematical principles of aeronautical design. Using inquiry and project based learning, students apply an iterative design process to develop, test and evaluate engineered solutions for rockets and planes with opportunities to transfer knowledge and skills to automobile designs.

As students explore Aerodynamics (Stage 5 iSTEM Elective Module 5), they will acquire and demonstrate essential STEM fundamental skills and knowledge (Stage 5 iSTEM Core Module 1) that will underpin further learning and project work in years 9 & 10.

Duration

11 weeks

Outcomes

5.1.1 develops ideas and explores solutions to STEM based problems
5.1.2 demonstrated initiative, entrepreneurship, resilience and cognitive flexibility through the completion of practical STEM based activities
5.2.1 describe how scientific and mechanical concepts relate to technological and engineering practice
5.2.2 applies cognitive processes to address real world STEM based problems in a variety of contexts
5.3.1 applies a knowledge and understanding of STEM principles and processes

5.4.1 plans and manages projects using an iterative and collaborative design process
5.4.2 develops skills in using mathematical, scientific and graphical methods whilst working as a team
5.5.1 applies a range of communication techniques in the presentation of research and design solutions
5.5.2 critically evaluates innovative, enterprising and creative solutions
5.6.1 selects and uses appropriate problem solving and decision making techniques in a range of STEM contexts
5.6.2 will work individually or in teams to solve problems in STEM contexts
5.7.1 demonstrates an appreciation of the value of STEM in the world in which they live
5.8.1 understands the importance of working collaboratively, cooperatively and respectfully in the completion of STEM activities

Core & Elective Module Outcomes

C1.1 STEM investigations (systematic observation, measurement, experiment formulation, testing and modification of hypotheses
C1.2 the use of STEM in developing solutions to problems (hardware & software)
C2.1 STEM principles (strength of materials, material properties, fluid mechanics, electricity & magnetism and thermodynamics)
E5.1 research and exploration (interpreting and analysing data, quantitative and qualitative research, surveys, interviews, observation & testing and experimenting)
E5.2 technologies related to aerodynamics (wind tunnels, smoke tunnels, computational fluid dynamics (CFD)
E5.3 aerodynamics principles (dynamic, static friction, drag ratios, lift, drag, weight, thrust, Finite Element Analysis (FEA) & flight)
E5.4 aerodynamics forces (lift, drag, weight, thrust, simple vectors & efficiency)
E5.5 aerodynamics design solutions

Unit overview

Students explore the mathematical, scientific, technological and engineering principles of Aerodynamics and apply STEM Fundamentals in the design of practical projects using an engineering design process. Students develop an understanding of STEM connections of Aerodynamics within the world they live, including related skills, industries and careers.

Students investigate past, current and emerging technologies and design elements through the development of prototypes to simulate the impacts of aerodynamic principles on aesthetics, efficiency and function of engineered rocket, aeroplane and automobile solutions. Students develop inquiry and project based learning skills appropriate to STEM practice through both individual and collaborative tasks using relevant software and hardware to produce engineered solutions.

Students design, produce, evaluate and communicate solutions to aerodynamic problems related to lift, drag, weight and thrust to meet detailed specifications.

Resources overview

The resources and links listed below are referenced within the program but is not an exhaustive list of resources available. Teachers can add to these resources as needed.

Physical resources

- Nuts & Bolts Bottle Rocket Folio.
- Skylap teaching resource pack.
- Rocketman Bottle Rocket Launcher & Power Anchor Testing Device.
- Splat 3D tools.

Websites

- Careers with STEM
- How to build a water rocket
- Aerodynamics in Racing
- What are wind tunnels (NASA)
- Aeronautical Velocity Challenge
- Excite and Educate (Bottle Rocket Equipment)
- Designability (Skylap planes and cars)

Videos

- Principles of flight
- Coanda effect
- Bernoulli's principle
- Newton's third law of motion
- Paines flyish fish rocket

Content	Teaching and learning	Evidence of learning	Adjustments and registration
Week 1 • Develop a shared definition of STEM, identify STEM skills with reference to the iSTEM process (Engineering Design Process) and explore why STEM careers are important in local, national and global contexts.	**Teacher** • Outline classroom expectations and lesson organisation. • Demonstrate online learning platform (for example: how to find, login and use Google Classroom). • Introduce the unit by discussing the use of STEM skills and equipment in society and how technological innovations impact on career opportunities through generations. The use of a comparison or example related to aerodynamics (skill or technology changes from 1850s railway innovation to bullet trains) will help set the tone for the unit but encourage students to share ideas of other industries such as Cyber Security or the impacts of rapid prototyping technologies across multiple industries. • Draw attention to essential skills or soft skills such as Collaboration, Communication, Creative Problem Solving and Critical Thinking skills as well as Resilience / Grit as desirable foundations and employability skills. **Students** • Complete brainstorming exercise in student booklet or online tools such as Google Draw, Lucid Charts, MindMup or Coggle (collaborative mindmapping).	• Students responses demonstrate an understanding of: ○ the use of STEM equipment in today's society. ○ impacts of innovation on career opportunities ○ the classification of STEM skills. • Students justification of the classification of STEM skills demonstrates an understanding of transferable and desirable employability skills in future focused careers. • Students exploration and articulation of the perception of mistakes as both positive and negative outcomes, develops a foundation for embracing interactive design, resilience and a solution focused mindset.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	As a Class ● Class discussion – classifying STEM skills; student volunteer to write on the board or record ideas in a shareable document with teacher facilitating discussion. ● Class debate - Mistakes are the magic of innovation. **Teacher** ● Gives verbal feedback and elaborates on content raised by students. Teacher suggests possible classifications and connections of STEM skills between industries (for example applied mathematics, problem solving and iterative design across a wide range of Engineering, Science and Technology disciplines). ● Leads a class reading of a Careers with STEM career profile to scaffold identification of STEM skills. ● Outlines the stages of the iSTEM process and emphasises the importance of iterative design, inclusivity and resilience in problem solving. **Students** ● Individually or in pairs read a different career profile article from the Careers in STEM magazine or website. Think, Pair, Share with students adding new skills or ideas to their mindmaps. This activity works best with several pre-selected articles with students randomly receiving articles.	● Student familiarisation with the iSTEM process will establish portfolio skills and a scaffold for future assessment.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	● Identify examples, tools or strategies for each stage of the iSTEM process. **Optional extension** ● Students to research a chosen career in aerodynamics with a focus on identifying skill sets and qualifications. • Students evaluate the effects of engineering, both positive and negative on society by researching engineering disasters.		
Week 2 ● Define aerodynamics and investigate how aerodynamic forces (lift, drag, thrust) and scientific principles (Bernoulli's principle, the Coanda effect, and Newton's third law of motion), affect form and function of a variety of engineering solutions: ○ rockets ○ planes ○ cars ○ trains ○ motorcycles.	**Teacher** ● Define aerodynamics. ● Outline the four basic forces within aerodynamics; ○ lift - keeps an aircraft airbourne ○ thrust - momentum to propel an aircraft forward. ○ drag - resistance to hold an aircraft back. ○ weight - force of gravity pulling an aircraft down. **Class** ● Class discussion - Round Robin Brainstorm Technique (split the class into 5 groups) with each group sharing their ideas on a given question with the class; record answers on the board or in a share document (this will be revised after watching the video). ○ How are the designs of rockets and planes affected by aerodynamics? ○ How does wing design impact and create lift? ○ Which components of an aircraft would be responsible for creating thrust? ○ How does rocket fin design affect drag?	• Students are able to outline the four principles of flight. • Students responses demonstrate an understanding of at least one of the principles of aerodynamics (Coanda effect, Bernoulli's Principles & Newton's third law of motion).	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	○ Why do we need to consider weight in the design of different aircrafts? ○ What is the difference between a fluid and a liquid? ● Watch the Principles of Flight ; discuss the previous answers and adjust as needed in student notes or in the shared document. **Student** ● Sketch thumbnail diagrams explaining how lift, thrust, drag & weight are applied in rocket designs. ● Experiment with the forces of aerodynamics using a simulation to complete the Rocket Launch Challenge. ● Students choose one of the scientific principles listed, watch the video and write a summary of how the aerodynamic principle affects lift: ○ Coanda Effect ○ Bernoulli's Principle ○ Newton's thrid law of motion **Optional adjustment** ● Teacher demonstrates scientific principles of aerodynamics with a simulated experiment: ○ Coanda Effect - hair dryer and ping pong ball and basketball (video example) ○ Bernoulli's Principle - hair dryer and ping pong ball (video example) ○ Newton's third law of motion - tennis ball (video example).		

Content	Teaching and learning	Evidence of learning	Adjustments and registration
Week 3 • Explore Aeronautical rocket fin design concepts.	**Teacher** • Introduce the Bottle Rocket Folio (iSTEM Booklet) and outline the requirements of the Bottle Rocket Challenge. • Outline the materials needed or provide an example of a pre-constructed bottle rocket. • Review the aerodynamic force of drag. **As a class** • Watch an example test flight of a bottle rocket for the Aeronautical Velocity Challenge - Paines Flyish Fish Rocket (Facebook Video). • Using the 'Define the Problem' template in the Bottle Rocket Folio, brainstorm and record ideas on how to engineer a rocket for the following areas: ○ aerodynamics ○ operational Requirements ○ low Weight ○ stable Flight. **Student - Pairs** • Research requirements of the Australian Aeronautical Velocity Challenge (Bottle rockets). • Plan a timeline for the development of a bottle rocket by completing the 'Identify Constraints' pages of the Bottle Rocket Folio ○ construct a GANTT chart ○ identify materials ○ identify project criteria ○ identify tools and equipment.	• Students demonstrate knowledge of the scientific method through exposure to a range of experiments related to aerodynamics. • Students work collaboratively to develop processes to solve set problems related to aerodynamics (i.e. Aeronautical Velocity Challenge). • Students apply the iSTEM process to develop a rocket prototype.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	● Research rocket fin designs and complete the 'Brainstorm' pages of the Bottle Rocket Folio: ○ *Activity:* draw thumbnail sketches of five different fin shapes ○ *Activity:* draw four bottle rockets (two stage rocket, engine gimbal, canards and retro rockets) ○ *Activity:* calculate the surface area of fin shapes (triangle, quadrant, rhombus & trapezium) ○ *Activity:* Design a fin outline onto bottle shapes with a 2500mmsq surface area. **Optional adjustment** Teacher to give students images of example fin designs and discuss the impacts of fin design on drag. **Optional extension** Students to experiment with water rocket simulation software, manipulate variables and analyse statistical data.		
Week 4 • Explore the concepts of stable flight (Centre of Pressure & Centre of Mass). • Design a bottle rocket prototype.	**As a Class** • Watch the Bottle Rocket Folio Videos 1 – 2. • Watch and follow along with the Splat 3D Water Rocket tutorial. **Students - Pairs** • Brainstorm activities continued:	• Students responses demonstrate an understanding of how the distance between the Centre of Mass and Centre of Pressure affects rocket stability during flight. • Students apply an iterative design process in the	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	○ *Activity:* Construct a simple paper prototype and conduct stability tests to experiment with Centre of Pressure (CP) & Centre of Mass (CM) ○ *Activity:* Sketch and explain spin stabilisation ○ *Activity:* Brainstorm two ideas to guide a rocket during a sideways lift-off. • Each group member draws and labels an isometric view of a potential rocket design by completing the 'Design' pages of the Bottle Rocket Folio. • Evaluate each design in the group and choose the best design to use for the prototype (Complete the Prototype page of the Bottle Rocket Folio). ○ *Activity:* Research and describe two processes for rapid prototyping. **Optional Extension** • Research which plastic polymer is used in the bottles for student rocket prototypes.	creation and refinement of prototypes. • Students labelled drawing demonstrate their intended design and how it links to aerodynamic forces and principles.	
Weeks 5 - 7 • Construct a rocket prototype. • Apply aerodynamic rocket knowledge to aeroplanes. • Describe characteristics of past, current and emerging aeroplane designs. • Test, evaluate and refine bottle rocket designs.	**Teacher** • Set two dates (initial test & refinement test) for rocket testing (outside or in the school gym). • Demonstrates the Rocketman bottle rocket launch system and facilitate rocket launches (complete risk assessment prior to launch dates). • Outline safety guidelines for the Rocketman equipment. • Introduce Skylap project – refer students to the student workbook.	• Students demonstrate the 4Cs (communication, collaboration, creative problem solving and critical thinking) in the construction of a rocket prototype. • Students responses demonstrate an understanding of the design features of historically significant aeroplane designs.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
• Generate and develop design ideas using drawing techniques. • Use a variety of techniques to communicate and present the development of design ideas.	**Students - Pairs** ● Collaboratively build a rocket prototype using appropriate tools and materials. ● Launch rockets and document distance, height & accuracy results on the 'Evaluate & Test' pages of the Bottle Rocket Folio. ● Refine rocket designs and conduct second launch test; complete the 'Iterate" page of the Bottle Rocket Folio. ● Draw a 1:1 scale of the final rocket design (paper or computer aided design); complete the 'Communicate & Share' page of the Bottle Rocket Folio. ● Record a 2 minute video explaining the final rocket design and how aerodynamic principles were applied; justify design change choices. **As a class** ● Watch rocket launches and provide verbal or written (PMI Chart) constructive feedback of rocket designs for fellow student groups. ● View a range of historically significant aeroplane designs. ● Discuss the role of innovation and aerodynamics in the changing designs of aeroplanes (past, current & emerging). **Optional extension**	• Students labelled drawing demonstrate design modifications and an appreciation of the iterative design process.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	• Students create a multimedia presentation explaining the significant changes to aeroplanes throughout history with at least one emerging design concept with explanations of the effects of aerodynamic principles and forces for each.		
Week 8 - 11 • Explain and compare aerodynamic principles of rockets, planes and cars (extension). • Investigate wind tunnel technology. • Select and safely use equipment to construct a Skylap Planes. • Plan and document a procedure (sequence) for the construction of a Skylap plane. • Test and evaluate the designing and producing of a textile item using a variety of techniques including self-evaluation and peer evaluation. • Use feedback from evaluation to modify project work and ensure a quality result.	**Teacher** • Demonstrate and outline safety guidelines for the Skylap Power Anchor equipment. • Demonstrate constructions techniques for balsa wood planes and outline safety guidelines for equipment use. **As a Class** • Watch the What are wind tunnels (NASA). • Discuss the importance of using wind tunnel technology to test and evaluate prototype designs. **Students** • Work individually or collaboratively to produce and evaluate a Skylap plane with supporting documentation by completing the student workbook. • Demonstrate safe use of equipment. **Optional Extension** • Experiment with the design of balsa wood cars for the the Power Anchor equipment; highlighting the applications of aerodynamics for automobiles. **Optional adjustment**	• Students are able to formulate a plan of action that accounts for the time they have available. • Students are able to explain the correct and safe use of Power Anchor equipment. • Students are observed during practical activities using Power Anchor and construction tools equipment. • Students demonstrate an understanding of the manufacturing procedure by creating a sequence of construction. • Students select the correct tools and equipment for the production of their Skylap plane.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	• Teacher provides partially or pre-constructed planes or cars for testing with Power Anchor equipment with class discussion of aerodynamics for automobiles.		

Evaluation

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

Term 2 iBot – 9 iSTEM – Stage 5 program

Summary

Mechatronics engineering combines the fundamentals of mechanical, electrical and computer science to develop autonomous systems, such as robotic solutions which can be found in a range of industries. This unit introduces students to a variety of innovation projects and Robotics using Pitsco's Tetrix construction systems to deliver Mechatronics 1 (Core Module 3) and Motion (Elective Module 6) of the Stage 5 iSTEM syllabus. The iBot unit sets the foundations of engineering principles and using circuit boards and remote control systems to manually control actuators.

Using inquiry and project based learning, students apply an iterative design process to develop, test and evaluate engineered robotics solutions while exploring ethical considerations related to the robotics industry, including the impacts and limitations of artificial intelligence. By applying engineering principles, students will build robotics solutions and integrate manual control to navigate obstacles. Through extension, an opportunity exists to experiment with sensors and computer coding to achieve automated movement, a concept which will be later explored in Year 10 as part of the Mechatronics 2 unit using the Tetrix platforms.

Students will simulate industry skills and knowledge through both individual and collaborative tasks. This unit aims to strengthen students critical and creative thinking skills, as well as cognitive flexibility in solving construction problems. Preceding units in both Year 9 & 10 will build upon the fundamental skills of robotics, electric circuits and computer science developed in this unit.

Duration

8 weeks

Outcomes

5.1.1 develops ideas and explores solutions to STEM based problems

5.1.2 demonstrated initiative, entrepreneurship, resilience and cognitive flexibility through the completion of practical STEM based activities

5.2.1 describe how scientific and mechanical concepts relate to technological and engineering practice

5.2.2 applies cognitive processes to address real world STEM based problems in a variety of contexts

5.3.1 applies a knowledge and understanding of STEM principles and processes

5.3.2 identifies and uses a range of technologies in the development of solutions to STEM based problems

5.4.1 plans and manages projects using an iterative and collaborative design process

5.4.2 develops skills in using mathematical, scientific and graphical methods whilst working as a team

5.5.1 applies a range of communication techniques in the presentation of research and design solutions

5.5.2 critically evaluates innovative, enterprising and creative solutions

5.6.2 will work individually or in teams to solve problems in STEM contexts

5.8.1 understands the importance of working collaboratively, cooperatively and respectfully in the completion of STEM activities

Core & Elective Module Outcomes

C1.1 STEM investigations (systematic observation, measurement, experiment formulation, testing and modification of hypotheses)

C1.2 the use of STEM in developing solutions to problems (hardware & software)

C2.1 STEM principles (strength of materials, material properties, fluid mechanics, electricity & magnetism and thermodynamics)

E5.1 research and exploration (interpreting and analysing data, quantitative and qualitative research, surveys, interviews, observation & testing and experimenting)

E5.2 technologies related to aerodynamics (wind tunnels, smoke tunnels, computational fluid dynamics (CFD)

E5.3 aerodynamics principles (dynamic, static friction, drag ratios, lift, drag, weight, thrust, Finite Element Analysis (FEA) & flight)

E5.4 aerodynamics forces (lift, drag, weight, thrust, simple vectors & efficiency)

E5.5 aerodynamic design solutions

Unit overview

Students will explore a range of local, national and global innovation solutions before developing fundamental skills of mechatronics. Using an engineering design process (iSTEM Process) and the Pitsco Tetrix platform, students will collaboratively build robotic prototypes to meet specifications and solve a variety of construction challenges. Students investigate the scientific principles of motion as the experiment, with a variety of actuators to develop an understanding of manual remote control of robotic functions and movement. While computer coding is not a specific goal of this unit, an opportunity to apply or develop coding skills (block or text based) to include sensor inputs and outputs for movement control exists for high achieving students. Students continue to develop communication, collaboration and critical thinking skills to overcome construction and design challenges.

Resources overview

The resources and links listed below are referenced within the program but is not an exhaustive list of resources available. Teachers can add to these resources as needed.

Physical resources

- Tetrix Comp in a Box robotics kit (mats, ping pong balls, walls, barrels, etc).
- Pitsco Tetrix Prime Remote Control and Engineering Student and Teacher Resource Booklets (Tetrix Prime Engineering Mobile. Robotics & Tetrix Max Mobile Robotics).
- Pitsco Tetrix Prime and Max robotics kits.
- Projector or Smartboard, laptops or tablets.

Websites

- Pitsco Tetrix Resource Site
- Tetrix Prime RC Sample Activity
- Life Straw
- Amp Control & Newcastle University COVID 19 Ventilator Project
- Aussie Educator List of STEM challenges
- Careers with STEM
- STEMJobs
- National STEM Education Resource Toolkit
- KForce Top 5 STEM Emerging Careers
- Australian Defence STEM Careers

Videos

- Pitsco Tetrix How To Videos
- Controller Pairing with Tetrix Max / Prime
- Industry Innovation videos – iTeach STEM
- What is GDP? and How to measure the size of an economy?

Content	Teaching and learning	Evidence of learning	Adjustments and registration

Week 1
• Explore local, regional, national and global STEM innovation.
• Identify the positives and negatives of innovation in multiple contexts.
	Teacher
	• Introduce the unit by discussing the use of STEM and technology as a driving element of innovation to meet the needs of society. Engineers across various disciplines solve both simple and complex problems to meet the needs of different societal groups or industry goals; innovation can be viewed positively and negatively in relation to the values and traditions of a given generation, culture or society.
	As a Class
	• Class discussion –
	  ○ What is innovation?
	  ○ Is progress or innovation always a good thing?
	Teacher
	• Gives verbal feedback and elaborates on content raised by students.
	• Introduce the [Life Straw] video as an example of an innovation project started in 2005.
	As a class
	• Class discussion –
	  ○ What problem is the Life Straw attempting to solve?
	  ○ Does the problem in 2005 still exist or has it changed?
	  ○ Can the Life Straw be used to solve local, regional, national or global problems?
		• Students responses demonstrate an understanding of:
		  ○ innovation in society
		  ○ generational, cultural and / or historical perspective of innovation
		  ○ evolution of products or solutions to meet changing societal needs.
		• Students actively contribute to discussion and critical analysis of a STEM solution for a specified purpose.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration

	Teacher
	• Gives verbal feedback and elaborates on content raised by students. Teacher suggests possible classifications or examples of how the device can be used in a local, regional, national and global context.
	Students – Pairs
	• Investigate and research the Life Straw website to answer the following questions:
	  ○ What was the original problem Life Straw was trying to solve and why?
	  ○ How have Life Straw products changes to address a different problem? Give at least two examples.
	• Share research with the class (Teacher to prompt group sharing of answers to the above questions).
	Teacher
	• Expand through discussion - STEM solutions have specific functional requirements that differ depending on the nature of the problem and society the solution seeks to serve. Identify examples of local, regional, national and global innovation projects.
	Student
	• Complete brainstorm of issues important to them.
	• Complete classification of brainstorm ideas / issues into local, regional, national or global concerns.
		• Students collaboratively investigate the evolution of a STEM solution and develop ideas to apply or expand the solution in a different context.
		• Students practice communication and oral presentation skills in articulating research findings with their peers.
		• Students identification of ideas and issues relevant their lives in need of STEM solutions.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration

	Teacher
	• Coordinate an industry presenter(s) for an incursion, class visit, virtual meeting or panel presentation of an industry based innovation (local and or regional) ie: Tamburlaine Organic Wines, Amp Control (Covid 19 Ventilator Project), Elite Robotics (self-driving lawnmower), AusSTEM (Kookaberry Microboard), Nuts & Bolts (Splat 3D Tool), etc to address the following;
	  ○ problem needing to be solved
	  ○ challenges / obstacles
	  ○ process of design
	  ○ skills or qualifications of presenter(s).
	As a Class
	• Students ask presenter questions about the product or problem.
	Optional Adjustment
	• Provide written, short case study videos or articles with examples of local, regional, national, & global innovation projects with questions (5W's & H) to answer for each category example.
	Optional Extension
	• Students to research an existing solution to a chosen example of local, regional, national and global problems listed in the class discussion. Present findings in a creative way that does not involve writing a report or making a PowerPoint slideshow.
		• Students engage with industry experts and demonstrate an understanding of:
		  ○ nature of work completed by the expert(s)
		  ○ societal context (local, regional, national and / or global) of the problem or solution presented
		  ○ skills and / or qualifications needed to pursue similar career pathways.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	• Students (Groups) brainstorm an idea to solve one of the problems presented. Solutions could be entered into a variety of competitions including the Hunter Young Business Minds Awards, Google Science Fair, Imagine Cup, Tech Girls are Superheroes, Young ICT Explorers, etc.		
Week 2 • Identify potential emerging STEM careers. • Investigate multiple STEM careers with identified skills and qualification / education pathways.	**Teacher** • Introduce the inquiry question and requirements for Term 2. **Assessment Task** ○ Question: How has local, regional, national & international STEM innovation impacted economic growth and emerging careers? ○ Constraints: 1. Students randomly provided with 1 STEM career by the teacher and are allowed to choose 1 STEM career to include in their project. 2. Students must answer the question in a creative way which does not include a written report, typical speech or slideshow. 3. Students should be encouraged to use innovative STEM tools from the Lending Library and / or existing STEM skills to deliver their answer to the question. 4. Students should include a brief outline of the emerging careers investigated and the skills / qualifications needed with specific references to impacts on economic growth and classification of local, regional, national and global opportunities for each career investigated.	• Students are able to outline the requirements of the assessment task and clearly identify constraints. • Students demonstrate idea generation techniques and apply creative problem solving in selecting, planning and developing a chosen method of presentation. • Students demonstrate an understanding or application of: ○ emerging STEM career pathways ○ impacts and importance of STEM skills on national and global economies ○ multiple research techniques and or the need for multiples	

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	5. Assignment due 4 – 6 weeks after notification depending on school's assessment guidelines and schedule. 6. One class a week until submission, should be dedicated to project work and teacher mentoring with the majority of the assignment completed outside of class time. • Introduce the concept of Emerging STEM Careers using the 5 Future STEM Careers that Don't Exist Yet website; encourage class discussion on each career highlighted in the article. • Introduce the concept of economic growth with the What is GDP? and How to measure the size of an economy? video. • Outline the importance of STEM skills to the Australian GDP using the National STEM Education Resource Toolkit. • **Challenge question:** What is the current Australian GDP? **Students** • Research the randomly assigned STEM career using a variety of information sources. • Students brainstorm at least 3 other emerging STEM careers and choose the most interesting career for further investigation and inclusion in their assignment. **Optional adjustment**	sources in finding various forms of data ○ education pathways for assigned and selected STEM careers ○ effective time management strategies for independent and group work.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	• Teacher to give students a list of potential STEM careers and resources to choose from (Careers with STEM Magazines, various links provided above in resource lists).		
Week 3 - 8 • Investigate different types of robotic solutions. • Explore positive and negative perceptions of issues related to robotics industries. • Understand ethical responsibilities surrounding robotics and artificial intelligence. • Develop construction and problem solving skills to collaborative design robotics solutions to specification challenges. • Understand the principles of motion using manual Remote Control (RC) control of actuators. • Identify robotic components related to motion and power supply.	**Teacher** • Introduce the concept of robotics vs artificial intelligence and the ethical concerns of the robotics industry (1 – 2 videos at the start of each lesson, followed by brief discussion and practical robotic construction activities). o Types of robots o What is a bionic robot? o What is Robot Ethics? o Who is Sophia? o Watson Destroys Humans in Jeopardy o What are Asimov's Three Laws of Robotics? o How we trained AI to be sexist o Siri vs Hal (AI Gender stereotypes - Satire) o Will robots take our jobs? o The rise of the machines **As a class** • Discuss the ethical concerns of robotics and artificial intelligence (choose a different topic or video(s) for the start of each lesson). • ***Debate*** – Robots are man's new best friend (completed at the end of the unit, once all topics above have been explored). **Students**	• Students responses demonstrate an understanding of the ethical concerns, perceptions and classifications of robotics: o common stereotypes o potential risks of AI and or robotic systems o moral responsibilities and challenges related to morality of robotics o scope of robotic uses across various industries o both human and robotic limitations. • Students justify their perspectives of the ethics of robotics with articulation of supporting evidence in a robust debate format. • Students generate ideas, research examples and	

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	• Using mindmap software, brainstorm the positives and negatives of robotics in society; find examples of robotics innovation within the following industries: ○ Hospitality ○ manufacturing and Production ○ recreation / Entertainment ○ Agriculture ○ Transportation ○ Security / Defence ○ Consumer convenience products. • Make notes in Google document or student booklet – ‘ethical concerns of robotics’ (this could be used as a scaffold for the end of unit debate outlined above). **Teacher** • Outline the Tetrix robotics platform and scaffold self-directed learning in groups; ○ demonstrate simple building techniques ○ assign students into groups of 2 - 3 ○ direct students to the Tetrix RC challenge booklets ○ explain the goal of the project; complete 3 – 4 Tetrix activities; achieve manual control of robots using RC function ○ demonstrate a sample activity – Tetrix Prime RC Sample Activity ○ allocate students into groups using either the Prime or Max kits. **Students**	record findings. • Students ability to:	

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	• In groups – complete a series of engineering and robotics construction challenges using the Pitsco Tetrix platform; ○ Prime Kit – 1. Activity 1 - Think like an Engineer: Build & Run a Robot 2. Activity 2 - Drivetrains: Build the Car Bot 3. Activity 3 - Drivetrain modifications 4. Optional: Drive and Speed Challenge (Students choose one of the 4 activities to complete Activity 6 -9) ○ Max Kit – 1. Activity 1 - Build the Robot, run the maze 2. Activity 2 - Wave the flag 3. Activity 6 - Inch Worm 4. Optional: Design Challenges (Students choose between challenge 1 – 4) ○ using a chosen robotics design, navigate an obstacle course using RC / manual control. **Optional extension** • Students to write a summary discussing societal perceptions of robotics and artificial intelligence. • Design an obstacle course using the Tetrix Comp in a Box kit and or the construction of obstacles using recycled materials or found objects. • Design a bionic robot using RC manual control to	○ effectively communicate design concepts and constraints ○ apply creative problem solving and cognitive flexibility in overcoming construction challenges ○ apply self-direction and appropriate time management techniques in the construction of multiple robotic solutions ○ interpret and apply technical instructions in the construction of robotic designs to meet specifications ○ identify and understand the function of various robotic components ○ select appropriate tools and components, including parts specific to motion and manual control, in the safe construction of robotic solutions.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	simulate a biological function or movement of the chosen animal; present function to the class or create a how to construction video highlighting bionic robot function. • To include block based coding, choose activities from either the Tetrix Prime and EV3 or Tetrix Pulse Robotics Controller booklets (This adjustment would only use the Tetrix Prime kits). • Use Tetrix Prime board to include sensor control & computer programming to achieve simple automation.		

Evaluation

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

Term 3 Sense-sational – 9 iSTEM – Stage 5 program

Summary

Computer Science is the study of computing concepts which includes hardware and software, internet and networks. It is a field of study which also overlaps with electrical engineering. In this unit students explore the ethical considerations and career opportunities of data and cyber security while applying fundamental skills of Computer Science in the design and development of a mini project to create an interactive installation.

This unit aims to strengthen students critical and creative thinking skills, as well as cognitive flexibility in solving problems. Preceding units in both Year 9 & 10 will build upon the fundamental skills of electric circuits and computer science developed in this unit.

Duration

10 weeks

Outcomes

5.1.1 develops ideas and explores solutions to STEM based problems
5.1.2 demonstrated initiative, entrepreneurship, resilience and cognitive flexibility through the completion of practical STEM based activities
5.2.1 describe how scientific and mechanical concepts relate to technological and engineering practice
5.2.2 applies cognitive processes to address real world STEM based problems in a variety of contexts
5.3.1 applies a knowledge and understanding of STEM principles and processes

5.4.1 plans and manages projects using an iterative and collaborative design process
5.4.2 develops skills in using mathematical, scientific and graphical methods whilst working as a team
5.5.1 applies a range of communication techniques in the presentation of research and design solutions
5.5.2 critically evaluates innovative, enterprising and creative solutions
5.6.1 selects and uses appropriate problem solving and decision making techniques in a range of STEM contexts
5.6.2 will work individually or in teams to solve problems in STEM contexts
5.7.1 demonstrates an appreciation of the value of STEM in the world in which they live
5.8.1 understands the importance of working collaboratively, cooperatively and respectfully in the completion of STEM activities

Core & Elective Module Outcomes

C1.1 STEM investigations (systematic observation, measurement, experiment formulation, testing and modification of hypotheses)
C1.2 the use of STEM in developing solutions to problems (hardware & software)
C2.1 STEM principles (strength of materials, material properties, fluid mechanics, electricity & magnetism and thermodynamics)
C2.3 problem solving (nature of, strategies to solve, evaluation & collaboration)
C3.1 mechatronics (building mechatronic components, programming logic, writing macros & fault finding)
C3.2 technologies related to robotic sensors and transducers, manipulators, PLC's, actuators (pneumatic & hydraulic)
E7.1 CAD / CAM (3D drawing on an x, y & z axes in planes, basic commands in a 3D CAD package, CAM processes & engineering drawing)
E7.2 technologies related to CAM (Additive and Subtractive manufacturing, Computer Numerical Controls, CNC, mills, routers & lathes & LEAN Manufacturing processes)
E7.3 CAD / CAM operations - reading and interpreting engineering drawings, rapid prototyping, 3D CAD operations, Computer Aided Manufacturing (CAM) & 3D modelling
E7.4 3D environments (vectors, 3D Shapes, Computer Numerical Control, spatial comprehension & 3D Surface Modelling)
E9.1 processes of design (identifying problems, project management, developing solutions to problems & generating ideas)
E9.2 presentation and communication technologies
E9.3 realisation, evaluation, research methods and experimentation

E9.4 mechanical knowledge
E9.5 creative and innovative approaches to solve problems

Unit overview

Cyber security is an essential future focused skillset underpinning many STEM careers. Students will complete cyber security tutorials for password protection against hacking and experiment with ‘hacking for good’ skills. Extension opportunities for students to expand their knowledge of ciphers, data representation and securing online communication through encryption will be available.

As part of the mini-task component of the unit, students will expand their block-based and or line-based computer programming skills using a micro-board, such as Circuit Playground, Microbit or Arduino Uno, simple electronics and sensors to create a Vivid-like experience project. Student designs will also incorporate the use of the iSTEM process to conceptualise CAD / CAM components in the development of their interactive prototype. Some aspects of this unit will be incorporate individual learning to develop skills in breadboarding, computer programming and 3D modelling of designs. Students will pitch their design ideas with the class voting to determine the best concepts for collaborative production. Students will simulate industry team-based manufacturing by specialising in a chosen area or skill contributing to their groups final prototype design. Prototypes can be displayed and or showcased at community or school-based events, such as Cessnock Spring Awakenings, Newcastle Show or community fundraisers.

Resources overview

The resources and links listed below are referenced within the program but is not an exhaustive list of resources available. Teachers can add to these resources as needed.

Physical resources

- Micro-board (micro-controller) (Circuit Playground or Arduino Uno), sensors, breadboards, LED lights, speakers (only needed if using Arduino Uno. Circuit Playground is highly recommended as it has built in sensors, speakers and led lights which can be expanded with breadboarding), etc
- 3D Printer(s) and Laser Cutter
- Projector or Smartboard, laptops or tablets

Websites

- Cyber Security 101
- Difference between White, Black & Grey Hat hackers
- Information Privacy & Security – Grok Coding Tutorials
- Cryptography – Grok Coding Tutorials
- Micro:bit Cyber Security Unit – differentiation opion
- Web Application Security Cybersecurity Challenge – Grok Learning
- HyperWeb Case Study – VIVID Example Project (Circuit Playground)
- Vivid Sydney
- Circuit Lessons 1 and Circuit Lessons 2 – TinkerCAD
- TinkerCAD – 3D Modelling Software (Free)
- Circuit Board Design Class - Instructables
- MakeCode Tutorials – Circuit Playground
- Arduino Tutorials – Circuit Playground
- Arduino Integrated Development Environment (IDE)

Videos

- Cyber Security Basics
- Circuit Playground Express Online Course
- Circuit Playground Arduino Motion Sensor Tutorial
- Ultimate Guide to Arduino (Video Course) – Circuit Basics
- Spider Dress – Arduino Interactive & 3D Printed
- What is Vivid Sydney?
- Vivid Interactive Exhibit Examples 1 and 2

Content	Teaching and learning	Evidence of learning	Adjustments and registration

Week 1 - 3
• Define Cyber Security and Computer Science.
• Outline the need for computer programming skills in the world in which we live.
• Identify potential career and education pathways in Computer Science and Cyber Security.
	Teacher
	• Introduce the unit by discussing Cyber Security and Computer Science by highlighting the importance of each in society. Encourage students to collaboratively (class discussion or in pairs) develop a definition of each.
	As a Class
	• Watch Cyber Security Basics
	• Class discussion –
	  ○ What is Cyber Security?
	  ○ Why is Cyber Security necessary in today's world?
	  ○ Describe what a hacker or computer scientist looks like.
	  ○ Why are computer coding skills considered an essential STEM skill?
	• Watch Hacking for Good
	Teacher
	• Gives verbal feedback and elaborates on content raised by students.
	• Introduce the Grok Learning Cyber Security tutorials for Information and Privacy; demonstrate the login process and facilitate self-directed learning in the completion of tutorials.
	• *Outline Assessment Task 3* – Coding tutorials log and practical coding challenge (due Week 5-6, Term 3) log requirements:
		• Students responses demonstrate an understanding of:
		  ○ cyber security risks
		  ○ applications of Computer Science
		  ○ importance of computer coding as a STEM skill
		  ○ role of an ethical hacker
		  ○ potential career pathways in Computer Science and Cyber Security.
		• Students apply self-directed learning skills in the completion of online tutorials.
		• Students practice coding skills to solve problems related to password protections, privacy and encryption.	

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<td>
date
screen Shot of code or badge
list challenges and / or something learned
Student

Investigate the types of Cyber Security threats by visiting the Built In website.
Research the difference between white hat and black hat hackers.
Sign up for a free Grok Learning account and enrol in the course as directed.
Complete coding tutorials and record process of completion at the end of each lesson in a digital coding log:
date
screen Shot of code or badge
list challenges and or something learned
practical coding challenge completed in class time

Optional Adjustment

gain a greater understanding of the importance of cyber security and explore the need to create a strong password before writing algorithms and programs to create their own ‘strong password generator’ using the micro:bit. Ideally, this unit should be taught after Computing fundamentals.

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Students identification of ideas and issues relevant their lives in need of STEM solutions.
Students justification of the classification of local, regional, national and or global STEM solutions.
Students engage with industry experts and demonstrate an understanding of:
nature of work completed by the expert(s)
societal context (local, regional, national and or global) of the problem or solution presented
skills and or qualifications needed to pursue similar career pathways.

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Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Optional extension • More advanced students to complete the Grok Cryptography tutorials and / or participate in Grok Web Applications challenge		
Week 4 - 6 • Investigate the use of sensors and computer programming in the Rockets design of interactive art or exhibition experiences, such as Vivid Sydney. • Apply the iSTEM process in the conceptualisation of an interactive prototype to design specifications. • Extend coding skills to manipulate input sensors to control visual and auditory outputs using an Arduino compatible micro-board. • Develop an understanding of circuits using breadboarding techniques to extend micro-board functions. • Demonstrate oral presentation skills to communicate interactive prototype concept	**Teacher** • Outline *Assessment Task 4* (due Week 3, Term 4). • *Mini Task Goal:* Integrate coding, CAD / CAM and simple electronics to create an interactive experience or exhibit piece based on theme relevant to student and or community (Teacher chosen theme - Climate Change, Equality, etc). ***Constraints:*** 1. Each student must: ○ investigate at least two types of existing interactive projects. ○ develop a concept based on the specified theme outlined in an iSTEM portfolio (idea generation, design sketch thumbnails and a 3D CAD design). ○ present or pitch their concept to the class via a 2 minute presentation or video. ○ critically evaluate peer design concepts and vote on the 5 best ideas; 3 votes per person (can only vote for self once). ○ sign up for one of the five chosen projects to work collaboratively as a member of the manufacturing team.	• Students are able to outline the requirements of the assessment task and clearly identify constraints. • Students apply the iSTEM process to demonstrate idea generation techniques and apply creative problem solving in selecting, planning and developing a prototype concept.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
using an entrepreneurial or elevator pitch format. • Develop knowledge, skills and understanding of the safe operations of a laser cutter. • Development knowledge, skills and understanding of the safe operation of a variety of 3D printing technologies. • Apply advanced manufacturing skills using CAD / CAM systems to the production of prototypes.	○ experiment with computer programming (block-based or line-based coding) to control input and output devices ○ use TinkerCAD to create an animated 3D CAD prototype with integrated circuits and simulated breadboarding ○ isometric 2D drawing of prototype concept 2. Projects must include: ○ Address the theme provided by the teacher ○ Coded micro-board functions with breadboard circuits to control interactive features ○ At least one CAD / CAM component (3D printed and or laser cut) ○ At least one sensor (proximity, pressure, ambient light, infrared, accelerometer, gyroscope, etc) as an input device to create interactive feature(s) ○ At least one output device (sound, led lights, movement, etc) to create interactive feature(s) ○ Finished design must fit within the dimensions of 395mm (w) x 305mm (h) x 570mm (l) – 50 Litre Plastic Storage Container. ○ Introduce the TinkerCAD Circuit Lessons 1 and Circuit Lessons 2 tutorials. • Ensure Arduino IDE (Integrated Development Environment) is installed for student access or		

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	direct students to sign up for the web-based Arduino IDE. • Demonstrate simple input (sensor) and output (LED light) functions of the preferred Arduino Compatible Micro-board (Circuit Playground recommended - Circuit Playground Express Online Course). **Teacher** • Demonstration of the safe operation of the laser cutter and the various 3D printing options at the school. • Demonstrate the use of Adobe Illustrator and laser cutting propriety software in order to produce laser cut items. • Demonstrate the use of TinkerCAD to produce 3D drawings. • Demonstrate how to use transfer 3D drawings from a CAD package into files suitable for 3D Printing. **Students** • Utilise CAD / CAM processes using laser cutters and 3D printers to produce a name tag and small 3D object. **As a Class** • Investigate interactive exhibits for project inspirations: ○ watch What is Vivid Sydney? ○ watch Vivid Interactive Exhibit Examples 1 and 2	• Students demonstrate safe use of CAD / CAM equipment available at Cessnock High. • Students show proficient use of Adobe Illustrator and propriety software for the purpose of laser cutting objects. • Students produce 3D drawings using TinkerCAD • Students to produce a name tag and small 3D printed object. • Students complete simulated breadboarding and circuit design tutorials.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	○ Watch Spider Dress – Arduino Interactive & 3D Printed **Students – in pairs** ○ Read case study HyperWeb Case Study ○ Explore the Vivid Sydney website. **Students – individual** • Complete a practical coding challenge (*part of assessment task 3*) using the preferred Arduino compatible Micro-board (example: turn on a synchronised series of led lights; follow along with a video). • Students brainstorm at least 3 interactive solutions to meet project specifications. • Complete coding tutorials specific to the preferred Arduino Compatible Micro-board. • Use simulation software to experiment with breadboarding and circuit design. • Select, conceptualise and present (2 min persuasive elevator pitch) an interactive prototype concept. • Use a PMI (Plus, Minus, Interesting) scaffold to critically evaluate peer concepts. • Vote for the top 5 concepts (Kahoot or Google survey) to be collaboratively developed and manufactured into functional prototypes. • Sign up or express interest in the allocation of roles for one of the five prototype teams/concepts.	• Students apply computer programming skills to an Arduino compatible micro-board. • Students justify the selection of appropriate input and output devices to create an interactive exhibit or experience to meet design specifications. • Students research existing interactive solutions using multiple resource sources. • Sketch 2D isometric drawings of prototype concept. • Students apply effective time management strategies for independent and self-guided learning tasks (coding & circuit design). • Students use persuasive speech techniques to concisely pitch their concept to their peers.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Optional adjustment • Teacher to assign students to prototype teams based on observation of skills and classroom dynamics. • Use MakeCode Circuit Playground blockly or javascript IDE.	• Students critically evaluate peer prototype concepts using a P (Plus), M (Minus) and I (interesting) scaffold and vote for the five best concepts presented.	
Week 7 – 10 & Week 1 (extends 1 week into Term 4) • Actively contribute to collaborative projects to simulate industry manufacturing roles and team-based development procedures. • Develop CAD/CAM software skills to produce 3D and or 2D designs. • Experiment with CAD/CAM tools, such as 3D printers and laser cutters, to manufacture project components. • Integrate coding, circuit design and CAD / CAM skills in the	**Teacher** • Demonstrates further features of CAD / CAM to student teams assigned to CAD / CAM designing • Facilitate project work and team role allocations. Each team should contain the following roles assigned to students (4-6 students per team): ○ project & Communication manager (project management, portfolio production, maintain group communication record & prototype presentation development) ○ Project Coder(s) – recommend to be completed in pairs ○ CAD / CAM Designer (3D / 2D drawing and component production) ○ Circuit Engineer (circuit designs, circuit simulations, wiring / breadboarding.	• Students to be able to utilise 3D printing and laser cutting technologies effectively to solving design problems • Students effectively contribute in assigned roles to the design and manufacture of one of the five final projects. Groups to produce: ○ iSTEM process portfolio documenting the design and development of the prototype (written or video portfolios)	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
production of an interactive exhibit prototype. • Demonstrate presentation and communication skills to showcase a functional prototype. • Document the iterative design process in a written or video iSTEM portfolio.	**Students – Groups** • Collaborative development of project components according to assigned roles. • Conduct regular team meetings and articulate and / or seek feedback regarding design goals, challenges and achievements to the classroom teacher. • Submit a functional prototype for assessment, showcase and marking (Week 1, Term 4). **As a Class** • Test peer group prototypes and provide critical and constructive feedback to improve prototype designs (PMI chart).	○ design an animated version of the group prototype design using simulated breadboarding and 3D CAD tools ○ write computer code to control input and output devices to achieve interactive features ○ implement functional electrical circuits, wiring and breadboarding to automate prototype interactivity ○ design and manufacture CAD / CAM prototype components ○ presents or showcases a functional interactive exhibit prototype.	

Evaluation

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

Term 4 Up and Away – 9 iSTEM – Stage 5 program

Summary

Consolidation of learning and ideas is an essential component of STEM skill development. The Up & Away unit draws on prior knowledge, skills and concepts of earlier units with a significant focus on strengthening applied mathematics skills in practical projects around the theme of aerospace.

Students will experiment with drone technology to investigate introductory surveying and statistics career pathways before moving onto collaboratively designing simulated habitat scenarios to sustain human life in an off-world environment. Students will also have the opportunity to design a rocket launch system for the rockets created in Unit 1 (Aeronaut) which will require students to modify original design concepts and prototypes (Rocket Launcher continues in Year 10).

Duration

9 weeks

Outcomes

5.1.1 develops ideas and explores solutions to STEM based problems

5.1.2 demonstrated initiative, entrepreneurship, resilience and cognitive flexibility through the completion of practical STEM based activities

5.2.1 describe how scientific and mechanical concepts relate to technological and engineering practice

5.2.2 applies cognitive processes to address real world STEM based problems in a variety of contexts

5.3.1 applies a knowledge and understanding of STEM principles and processes

5.4.1 plans and manages projects using an iterative and collaborative design process
5.4.2 develops skills in using mathematical, scientific and graphical methods whilst working as a team
5.5.1 applies a range of communication techniques in the presentation of research and design solutions
5.5.2 critically evaluates innovative, enterprising and creative solutions
5.6.1 selects and uses appropriate problem solving and decision making techniques in a range of STEM contexts
5.6.2 will work individually or in teams to solve problems in STEM contexts
5.7.1 demonstrates an appreciation of the value of STEM in the world in which they live
5.8.1 understands the importance of working collaboratively, cooperatively and respectfully in the completion of STEM activities

Core & Elective Module Outcomes

C1.1 STEM investigations (systematic observation, measurement, experiment formulation, testing and modification of hypotheses
C1.2 the use of STEM in developing solutions to problems (hardware & software)
C2.1 STEM principles (strength of materials, material properties, fluid mechanics, electricity & magnetism and thermodynamics)
C2.2 fundamental mechanics (basic units, prefixes, statics, dynamics & modelling)
C2.3 problem solving (nature of, strategies to solve, evaluation & collaboration)
C4.1 mechatronics and control technology (logic gates, mechanical and electrical actuation systems & motors)
C4.2 programming & computations (algorithms, calculating distance, trigonometry, circle geometry & input/output systems)
C4.3 design mechatronic solutions for a range of applications
E5.1 research and exploration (interpreting and analysing data, quantitative and qualitative research, surveys, interviews, observation & testing and experimenting)
E5.4 aerodynamics forces (lift, drag, weight, thrust, simple vectors & efficiency)
E5.5 aerodynamic design solutions
E11.1 site risk management and WHS in surveying (common surveying workplace hazards and associated risk control, site safety plan, PPE equipment & surveying software)
E11.2 technologies related to surveying (Total Station Theodolite (TST), GPS, digital terrain models & laser scanning)

E11.3 fundamental surveying principles (cadastral surveyors, engineering surveyors, mining engineers, hydrographic engineers, geodetic surveyors, GIS & photogrammetry)
E11.4 spatial data (appreciation of spatial skills, calculating distance, trigonometry, geometry & mapping)
E11.5 problem solving (design surveying solutions to a range of applications)
E12.1 Coding for Space (basic coding to manipulate wireless devices, manipulate sensors, actuators, remote sensing space, history and future, impact on daily life & space applications)
E12.2 technologies related to coding and space (microcontrollers, electronics, computer software, satellites and rockets & radio communication)
E12.3 space vehicles and experiments using STEM design methodologies (engineering requirements, circuit diagrams, electricity, radio and other waves, thermal conductivity, spectra & motion in 3D)
E12.4 data analysis and modelling (modelling data using software, analysing and drawing useful conclusions from data & efficiency)
E12.5 experimental design solutions to space related applications
E13.2 technologies related to statistical analysis (computer software for simulations & computer software for design and analysis)
E13.3 fundamental statistical analysis (basic statistical key figures concepts describing society, product comparisons, consumer behaviour, inflation, gross domestic product, data sources & evaluation of data sources)
E13.4 analyse, interpret, evaluate statistical information & communicate statistical findings

Unit overview

Drone technology is fast becoming an essential tool influencing traditional and STEM based careers, to create exciting new opportunities in Agri-Tech, Defence, Entertainment and Environmental Science industries. Students will explore how drones are used for both surveying and statistical careers through hands-on activities designed to specifically highlight mathematical connections in industry and strengthen mathematical skillsets. The bulk of High Flyer activities work best in an immersive day (incursion or excursion) format hosted in collaboration with industry representatives and educators delivering rotating experiences. Additional content and learning activities can be completed in class time, such as flying mini drones, drone flight manipulation through manual (RC controller) and automated (computer coding) control. Further opportunities to expand drone skills will be provided in Year 10.

Throughout the year, students have undertaken a number of engineering based challenges and explored the use of computer programming and sensor technology across a range of contexts. The Design My Space activities combine these skills with a greater focus on the importance of data collection and analysis in decision making. Students will collaboratively design a habitat to simulate an off-world living scenario. Each group will be provided with a different environmental science scenario for which they must utilise sensor technologies and conduct experiments related to air, food and or water management, to sustain human life for successful habitation on non-earth celestial bodies, such as Mars or the Moon.

To bring learning full circle, students will revisit Aerodynamics learning by engineering a rocket launch system for bottle rockets. The SISP Rocket Launcher activities will reinforce the importance of the iterative design process with students designing and manufacturing a launch system for their first iSTEM project (Bottle Rockets) in Term 1. Students will modify and / or redesign their bottle rockets for successful launch using their own launch system. The SISP Rocket Launcher is constructed using everyday materials and equipment, providing students with an opportunity to continue their STEM learning throughout the summer break. Rocket launcher projects will be briefly re-visted at the start of Year 10 iSTEM.

Students should be encourage to keep all project prototypes and portfolios in good condition to be displayed and or showcased at community or school-based events such as Newcastle Show, school events or community fundraisers.

Resources overview

The resources and links listed below are referenced within the program but is not an exhaustive list of resources available. Teachers can add to these resources as needed.

Physical resources

- Kookaberry (micro-controller) Design My Space Kit and student work booklets
- SISP Rocket Launcher work booklet
- Tello Drone Kits (Lending Library)
- SISP High Flyer Activity Pack
- A2 printed satellite images of drone flight location (such as industry partner locations, high school, or community location)
- Projector or smartboard, laptops or tablets
- Splat 3D tools (class set)
- Optional: CAD / CAM software (TinkerCAD, Google Sketchup) and equipment (3D Printer & Laser Cutter)
- Recycled materials and found objects / craft supplies for prototype construction

Websites

- Civil Aviation Safety Authority - Drone Safety & Regulations
- Types of Careers Using Drones – Interesting Engineering
- 10 UAV Jobs of the Future – How Stuff Works
- Nuts & Bolts Splat 3D
- SISP SPLAT 3D Paper Template
- Kookaberry Lesson Plans
- iTEACH STEM – Design for Space Resource List
- Moon Camp Challenge – Design a Moon Settlement using TinkerCAD
- NASA JPL – history and up to date information of NASA missions
- 40 Most Important Space Events – USA Today
- Top 10 Aussie Space Milestones – National Geographic

- Australian Space Agency – Past, present and future

Videos

- Drone Safety rules – CASA
- Dirty Dozen: 12 ways your drone can land you in trouble – CASA
- Drone Pilot Jobs – YouTube
- What are drones used for? – YouTube
- Splat 3D Video Tutorials – YouTube
- Australian Space Agency
- Challenges of living on Mars – Sky News YouTube
- How do we colonise the Moon? – Universe Today
- Building a Marsbase – YouTube

Content	Teaching and learning	Evidence of learning	Adjustments and registration
Week 2 - 3 **(Unit 3 extends into Week 1, Term 4)** • Investigate safety and operation rules of Unmanned Aerial Vehicles in Australia	**Teacher** • Facilitate collaboration with an industry partner to deliver the High Flyer event (excursion or incursion); obtain satellite prints of chosen location, print student worksheets and finalise risk assessment and student permission notes (See SISP High Flyer Resources). • Introduce drone technology and drone flight skills as an emerging STEM career. • Outline safety and rules of UAV (unmanned aerial vehicles) in Australia. **As a Class** • Watch the following videos: o What are drones used for? o Drone Pilot Jobs o Drone Safety rules o Dirty Dozen: 12 ways your drone can land you in trouble • *Class discussion* – o Are you interested in a drone related career? Why/Why Not & Which one? o How important is mathematics skills or what type of mathematics is used in drone careers? o *Optional debate* – drones technology shouldn't be controlled by the government. **Teacher** • Gives verbal feedback and elaborates on content raised by students.	• Students responses demonstrate an understanding of: o drone safety regulations o basic surveying and statistical connections to drone technology o potential career opportunities using drone technology o importance of applied mathematics in drone related careers	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Students • Investigate the types of UAV careers by researching Types of Careers Using Drones – Interesting Engineering & 10 UAV Jobs of the Future – How Stuff Works. • Actively participate in the High Flyers activities and complete the following work booklet pages; ○ calculating Area & Perimeter ○ designing a Drone Flight Path ○ ground Truthing ○ design a drone ○ data & Drones ○ drones in Marketing (Video editing) ○ manual vs Automated Drone Control. **Optional Adjustment** • Reduce the number of High Flyer activities. • Swap one of the High Flyer activities to include the Eagle Shadow Puppet activity with direct links to Dreamtime Stories (Aboriginal Elder). **Optional Extension** • Invite Year 6 partner primary school students; high school students are paired with a younger student to complete activities together in a mentoring model.	• Students apply self-directed learning, collaboration and communication skills in the completion of High Flyer activities. • Students practice mathematic skillsets to solve High Flyer challenge activities. • Students identify the difference between manual and automated control with the ability to outline appropriate scenarios for the use of both. • Students engage with industry experts using or related to drone technology.	
Week 4 - 8	**Teacher**		

Content	Teaching and learning	Evidence of learning	Adjustments and registration

• Investigate the history of space exploration and Australia's involvement in space exploration.
 	
• Explore the positives, negatives and challenges of Mars and / or Moon colonisation.
 	
• Apply STEM skills and an inquiry based mindset in the design and development of habitat design solutions.
 	
• Collect and analyse data in a simulated off-world habitation scenario.
 	
• Select appropriate tools, equipment, software and skills to safely design, develop and test habitat design solutions.
 	
• Conduct experiments and refine design concepts in habitat designs to sustain human life.
 	
• Work collaboratively to design habitat prototypes and creatively solve problems.
	• Introduce the Design for Space unit using videos:
	  ○ Australian Space Agency
	  ○ Challenges of living on Mars
	  ○ How do we colonise the Moon?
	  ○ Building a Marsbase
	• Outline Design my Space challenge activities using the Design my Space intro video *(See outline of scenarios below).*
	• Demonstrate the Kookaberry Micro-controller; simple sensor (ambient light) and data transmission to teacher Kookaberry (aka Command Centre).
	• Allocate students into groups of 2 – 3; randomly distribute Design My Space scenarios (scenarios will likely be repeated twice depending on the number of students in the class; duplicate scenarios should be completed as separate groups).
	
	Students - Groups
	
	• Apply self-directed learning and the iSTEM process to design an experiment using the Kookaberry micro-controller and appropriate sensors.
	
	• Use the Kookaberry How to Videos to learn the skills needed for chosen sensors.
	
	• Collect recycled and found objects to use in the chosen prototype design. (*Optional:* CAM / CAM technologies used to manufacture components).
		• Identify the role of Australians in Space Exploration.
		• Outline the challenges of colonising non-Earth celestial bodies.
		• Demonstrate an understanding of variables in habitat design necessary for sustaining human life.
		• Students are able to outline the requirements of the scenario allocated to their group.
		• Demonstrate the ability to select appropriate sensors to suit the design scenario allocated.
		• Students apply the iSTEM process to demonstrate idea generation techniques and apply creative problem solving in selecting, planning and developing a prototype concept.
		
		• Students collect and analyse data to determine prototype	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	• Document the prototype design using a blank iSTEM Process folio and record work completed in a daily mission log (standard work log template). • Collaboratively construct and test habitat design solutions to sustain human life as per the allocated group scenario. • Present prototype to class or panel of school representatives. ***Outline of Design my Space Scenarios:*** • CO_2 sensor (Low - Moderate) – detect and regulate CO_2 levels within the habitat with alarms for dangerous levels and the activation of a ventilation system (students blowing into a tube funnelled into the habitat to simulate CO_2 detection). • Water pump (High) with crash sensor or magnetism sensor – detect water levels and provide data to command centre for water (grey water and consumption water) levels; warning for low and high levels with activation of pump to water plants and or clean water usage limits. • Ambient light sensor (Moderate) – sun sets / rises turn on and off led lights or automatically move window coverings based on position of sun to provide adequate lighting and use minimal power. • Soil moisture sensor (Low) – detect water levels in soil for various plants, send wireless signal notifying astronaut to water plants or to activate water pump.	modification needs and answer questions relevant to the scenario allocated. • Students apply appropriate time management techniques to complete design challenges within a given timeframe. • Students keep an up-to-date and detailed mission log. • Students apply communication skills in the showcasing of a prototype to a panel of peers or school representatives. • Students use an iterative testing process to refine prototype designs based on critical analysis of data and sensor readings. • Students critically evaluate peer prototype concepts using a P (Plus), M (Minus) and I (interesting). • Students justify the selection of appropriate materials in	

Content	Teaching and learning	Evidence of learning	Adjustments and registration

	• UV sensor – detect safe levels of uv radiation for humans and equipment; experiment with coverings for habitat.
	Optional Adjustment
	• Allocate and assign groups based on the complexity of scenarios to meet learning needs of students.
	• Students to research the following websites and construct a historical timeline of important Space Exploration events:
	  ○ NASA JPL – history and up to date information of NASA missions
	  ○ 40 Most Important Space Events – USA Today
	  ○ Top 10 Aussie Space Milestones – National Geographic
	  ○ Australian Space Agency – Past, present and future
	Optional Extension
	• Students to design their own scenario to simulate habitation environment requirements on a Mars or Moonbase.
	Kookaberry Advanced Expansion Scenarios:
	• Heat transfer – detect and turn on heat pads, two hatches, once one room reaches a certain heat level than activate to open the second door to transfer heat (must be able to sense heat levels in
		the production of a prototype to meet design challenge specifications.
		• Students research existing interactive solutions using multiple resource sources.	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	two rooms), once heat level in both rooms is reached, heat pads turn off; • Solar panel - collecting sustainable energy and regulating usage of power between modules or habitats; send data to command centre to monitor energy outputs and make decisions on what equipment should or shouldn't be activated at a given time to conserve energy. • Smoke detector – simulate smoke or fire in a habitat by burning eucalyptus leaves in a crucible with smoke funnelled into the habitat with alarms raised (sound activation) and activation of either vents or an extinguishing system.		
Week 9 - 10 • Review aerodynamic principles of rocket designs. • Expand engineering skills to produce a rocket launcher prototype. • Apply an iterative design process to modify bottle rocket designs for use with a student designed rocket launch system. • Document prototype development using the iSTEM process.	**Teacher** • Facilitate project work and independent learning. • Introduce the Rocket Launcher iSTEM process booklet. **As a class** • *Class discussion* – review the principles of aerodynamics (students can use notes from Term 1). • Watch the Rocket Launcher introduction video **Students** • Collect materials and resources needed to construct a rocket launch pad. • Follow along with the tutorial videos to complete the Rocket Launcher iSTEM process work booklet.	• Students recall, articulate and apply aerodynamic principles in the design of a rocket launch system. • Students apply mathematics reasoning and calculations in the design and production of a rocket launcher prototype. • Students document progress and prototype development using the iSTEM process. portfolio (launch pad work booklet) documenting the design and development of the prototype. • Students modify or redesign a bottle rocket for successful launch using their rocket	

Content	Teaching and learning	Evidence of learning	Adjustments and registration
	Optional Extension • Students to complete the construction of their rocket launcher and modify / redesign a bottle rocket over the school summer break.	launcher prototype.	

Evaluation

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