Curriculum resource module

Year 5

Evacuation robot

Government of Western Australia
Department of Education

The STEM Learning Project is funded by the Department of Education and implemented by a consortium in STEM education comprising the Educational Computing Association of WA, the Mathematical Association of WA, the Science Teachers Association of WA and Scitech.

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The STEM Learning Project

The STEM Learning Project's aim is to generate students' interest, enjoyment and engagement with STEM (Science, Technology, Engineering and Mathematics) and to encourage their ongoing participation in STEM learning and the world of work. The curriculum resources will support teachers to implement and extend the Western Australian Curriculum and develop the general capabilities across Kindergarten to Year 12.

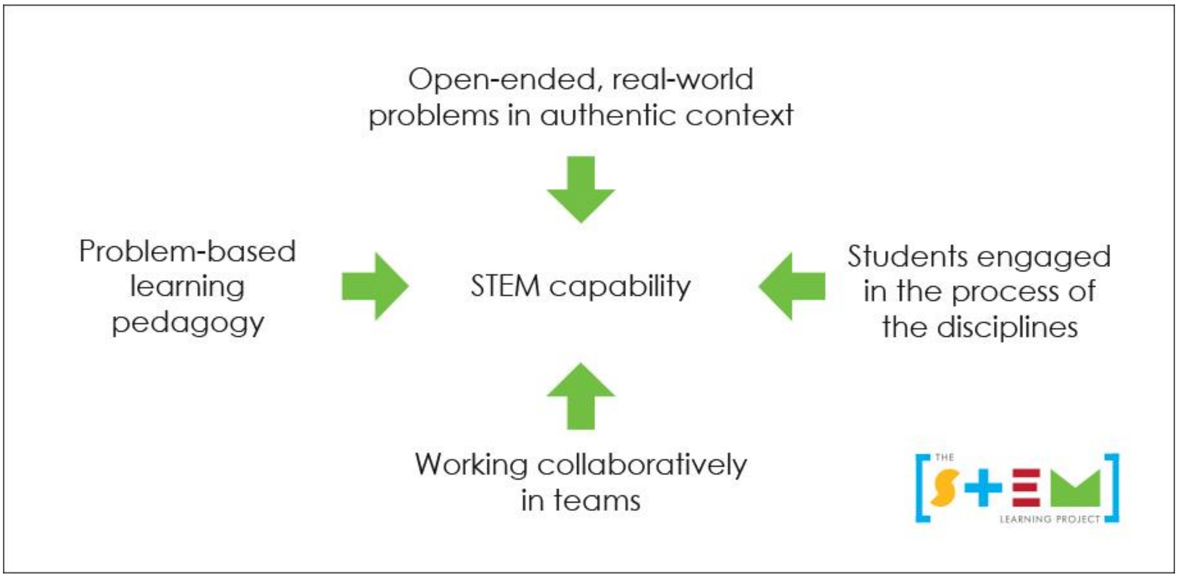
Why STEM?

STEM education will develop the knowledge and intellectual skills to drive the innovation required to address global economic, social and environmental challenges.

STEM capability is the key to navigating the employment landscape changed by globalisation and digital disruption. Routine manual and cognitive jobs are in decline whilst non-routine cognitive jobs are growing strongly in Australia. Seventy-five per cent of the jobs in the emerging economy will require creative and critical thinking and problem solving, supported with skills of collaboration, teamwork and literacy in mathematics, science and technology. This is what we call STEM capability. The vision is to respond to the challenges of today and tomorrow by preparing students for a world that requires multidisciplinary STEM thinking and capability.

The approach

STEM capabilities are developed when students are challenged to solve open-ended, real-world problems using problem-based learning pedagogy which engages students in the processes of the STEM disciplines working collaboratively in teams.



Year 5 – Evacuation Robot

Overview

Robots, drones and other automated systems are becoming increasingly prevalent in our daily lives.

This project leverages the rise of automated and autonomous systems being used to carry out routine and even dangerous tasks, and seeks to empower students to be not only smart consumers of technology, but creators and innovators in the digital technology space. In this module students work collaboratively to develop an algorithm and then program a robot or drone to lead students safely out of the school in the event of an emergency, to an evacuation point.

What is the context?

Swiftly and safely evacuating from a building can be a difficult and hazardous problem, particularly if escape routes are filled with smoke or debris, people are unfamiliar with the building, unaware of the dangers present, or even have some physical incapacity.

Automated systems, such as drones or robots, present an opportunity to provide a solution which minimises risk to human life.

In this module, students draw on a range of skills in a series of multidisciplinary tasks to design, and create an evacuation plan. Students develop measurement, computational thinking, design, and project management skills when cooperatively developing a solution to the problem.

What is the problem?

How can we design an evacuation route and program a robot to safely guide a class of students from their classroom to a muster point in the event of an emergency?

How does this module support an integrated STEM learning approach?

Students engage with the problem of evacuating students from their classroom in the event of a natural disaster. They do this by analysing evacuation plans, measuring and documenting evacuation routes and developing an algorithm and programing a robot to lead students to safety.

Mathematics is addressed when students create a grid reference map of their school for testing the solution for their evacuation robot; students describe locations and routes, using landmarks, directional language and grid references (ACMMG113). They list outcomes of chance experiments using fractions when assigned a disaster and location within the school (ACMSP116).

Students develop digital technology outcomes as they design a flowchart showing evacuation procedures using branching and iteration (ACTDIP019), apply this through a digital interface to a robot (ACTDIP018) and transfer the algorithm to a simple programming platform such as Scratch (ACTDIP020).

Students use digital technologies to present their solution to an audience beyond the classroom. ((ACTDIP022).

General capabilities that are addressed include Critical and creative thinking, Literacy, Numeracy, ICT capability and, Personal and social capability.

Activity sequence and purpose

Activity 1

RESEARCH

Students watch stimulus videos on the use of robots in dangerous situations and begin investigating evacuation procedures and risks for the school.

Robot! Get me out of here!

Activity 2

INVESTIGATE

Students map a representation of the school on a grid system. Students identify outcomes arising from potential disasters occurring at various locations in the school, and represent probabilities of these using fractions. They identify a safe route and program a robot to follow this.

Planning an escape route?

Activity 3

IMAGINE & CREATE

Students design an evacuation solution represented as an algorithm flowchart and transfer this to a simple programming platform such as *Scratch*.

What is the digital solution?

Activity 4

EVALUATE & COMMUNICATE

Students present their evacuation design solutions to members of the community beyond the classroom.

Let's pitch our solution

Background

Assessment	The STEM modules have been developed with the intention of providing learning experiences for students to solve authentic real world problems using science, technology, engineering and mathematics capabilities. Assessment opportunities will arise for teachers which are outlined here. Students will be assessed on their design portfolios (blog), grid reference system of the school, annotated diagrams and flowchart design solutions and their presentation. Students will also be assessed on their peer and group reflections in the blog to evaluate their collaborative working skills. This will be ongoing and formative in nature. The assessment rubric links outcomes to activities, and shows content descriptions and standards from mathematics and technologies. Students will also have the opportunity to further develop the general capabilities within Information and communication technology capability, Critical and creative thinking and Personal and social capability. Progress maps for these are included in the *General capabilities continuums* but are not for assessment purposes.
Learning outcomes	The students will be able to: 1. Explain what a robot is and how robots can improve our lives by assisting us. 2. Identify possible disasters that could occur at school and represent their probability as fractions. 3. Use the mathematical concepts and language specific to grid reference systems in order to create a map and identify locations at school. 4. Identify an escape route and design a flowchart that can be used as an algorithm as the basis for programing a robot 5. Document programming instructions in a systematic way, and successfully programs the robot so that it performs the desired actions required to lead a class to safety in an emergency situation. 6. Use digital technologies to organise and present information about the design and the design process.

	7. Work collaboratively to plan, develop and communicate ideas and information for solutions
Timing	There is no prescribed duration for this module. The module is designed to be flexible enough for teachers to adapt. Activities do not equate to lessons; one activity may require more than one lesson to implement.
Vocabulary	This module uses subject specific terminology. The following vocabulary list contains terms that need to be understood, either before the module commences, or developed as they are used. drone, algorithm, evacuation, system, branching, blog, reiteration
Consumable materials	A materials list is provided for this module. The list outlines materials outside of normal classroom equipment that will be needed to complete the activities.
Safety notes	It is expected that students will be using the internet to complete this module. It is essential that students are educated on internet safety including cyber bullying, privacy and protection.

Activity 1: Robot! Get me out of here!

Activity focus	This activity is designed to spark students' imagination and interest in the problem – how could we use a robot to assist with school evacuations? Students watch a number of stimulus videos on the use of robots in dangerous situations. Working in groups, students begin investigating evacuation procedures for the school. Students begin blogging about what they have learnt.
Teacher background information about content and disciplinary processes	A robot is a machine that can be programmed to complete complex series of tasks. Some robots can work by themselves, other robots are controlled by people with a remote control. Robots have sensors which let them detect and respond to changes (e.g., change in temperature or light levels). Robots are often used to do jobs that people can't (e.g., jobs that require super strength or are dangerous), or jobs that people don't want to do (e.g., boring, repetitive jobs). One example is a WA company Fast Brick Robotics who built a robot that can lay bricks and build a house. (www.fbr.com.au/). Any robots can be used for this Evacuation Robot module including, but not limited to, Sphero, Dash and Dot, Edison and Bee-Bot. For further information on how to use/program these robots see: Edison – meetedison.com/robotics-lesson-plans/ Dash and Dot – teachers.makewonder.com/ Sphero – tickleapp.com/ Bee-Bot – www.bee-bot.us
Learning outcomes	Students will be able to: 1. Explain what a robot is and how robots can improve our lives by assisting us (Technologies). 2. Interpret the school evacuation plan and explain why certain evacuation routes have been chosen (Science).

Equipment required

For the class:

Devices for research.

Preparation

Test links to videos and download to reduce streaming issues during lesson time. Locate and copy the school evacuation plans and photocopy or prepare them in a digital form for sharing.

Activity parts

Part 1:

Class discussion to determine prior knowledge on use of robots. This can be recorded as a brainstorm on a digital platform such as *Padlet* or on the whiteboard.

- What are robots used for? Why do they have different uses?
- What are drones and how do these help us?
- How are they controlled?

Engage students in the topic through watching a range of videos using a data projector or interactive whiteboard. Links to videos can be found in the digital resource section.

Part 2:

Working in small groups of two or three, students use devices to further research the uses of robots.

Examples of robot and drone uses include: aerial photography, disaster management, search and rescue, wildlife monitoring, storm tracking and forecasting.

Warehouse robots are programmed to follow tracks to locate and retrieve packages. They follow predetermined routes in the same way as an evacuation robot might.

Students share what they have learnt with the class before adding to the brainstorm from Part 1. Students can use a different coloured pen to distinguish between new and prior knowledge.

Part 3:

Students investigate evacuation procedures in the school. This could include a briefing from a Deputy Principal. They analyse the school evacuation plan and identify the current escape routes from a variety of rooms and discuss why they think those routes have been chosen. Students will deduce

	the criteria that led to the specific routes being chosen. Distance may have been only one criterion; others may have included the location of flammable materials, congestion and ventilation.
	Part 4: Teachers conduct a whole class discussion to review the main findings from the student research about robots and evacuation routes.
	Part 5: Students begin blogging what they have learned about robots and evacuation routes. Alternatively they could reflect on their learning in a digital journal as outlined in *Reflective journal.*
Digital resources	Tech and toys that keep learning fun www.juniorgamecreators.co.uk/creativity-technology-learning-play-dont-learn-code-code-learn/
	Tynker– create your first drone program www.tynker.com/blog/articles/ideas-and-tips/coding-at-school/programming-parrot-drones-with-tynker/
	How disaster technology is saving lives edition.cnn.com/2015/08/24/us/robot-disaster-technology/ www.bbc.com/news/technology-18581883
	How robots are changing search and rescue www.bbc.com/future/story/20140612-robots-to-the-rescue
	5 Amazing drone use ideas www.youtube.com/watch?v=1bg0vRQOc9Q
	Drone project aims to deliver rapid disaster response after cyclones www.abc.net.au/news/2017-03-31/drone-trial-to-deliver-rapid-disaster-relief-after-cyclones/8403334
	French farmers use drones to examine crops learningenglish.voanews.com/a/french-farmers-use-drones-to-examine-crops/2611191.html
	Drones in advertising www.businessinsider.com.au/drones-in-advertising-2014-9?r=US&IR=T

Telerobots are semi-autonomous robots that are controlled from a distance.
www.splash.abc.net.au/home#!/media/2090458/telerobots-we-need-you

Resources for class blogging

Edmodo

For providing clear feedback, many teachers like this learning management system
www.edmodo.com

Edublogs

A WordPress blogging platform.

The free version of Edublogs is rather limited in that you cannot include videos, use custom HTML to embed items into posts, or manage your students' accounts.

Edublogs.org

Tumblr
www.tumblr.com/

Kidblog

KidBlog is a free hosted blogging service designed for teachers to use with students. Teachers can create accounts for their students to use to write blog posts and to write comments on blog posts. Students do not have to have email addresses in order to use KidBlog

kidblog.org

Blogger

This is Google's free blogging service. It takes just a minute to start a blog through Blogger. Blogger offers a nice selection of colourful themes and templates to choose from. Customising the layout of your blog is as easy as dragging and dropping elements into place.

www.blogger.com

Activity 2: Planning an escape route

Activity focus	Students identify outcomes arising from potential disasters occurring at various locations in the school, and represent probabilities of these using fractions. They identify a safe route and program a robot to follow this using a grid system. Students continue blogging what they have learned as a record of the design process.
Teacher background information about instructional procedures	It is recommended that students work in small groups of three to four from this activity onwards. Mixed ability groups encourage peer tutoring and collaboration in problem solving. Collaboration is an important STEM capability. When making the grid, a durable surface for the robot to move over will need to be considered. This may involve laminating pages or placing the grids under Perspex. If paper is taped to tables the robots will be able to move over it however, it is not recommended for durability as the grids may become marked or torn.
Learning outcomes	Students will be able to: 1. Use the mathematical concepts and language specific to grid reference systems in order to create a map and identify locations at school (Mathematics). 2. Identify possible disasters that could occur at school and represent their probability as fractions (Mathematics). 3. Document programming instructions in a systematic way, and successfully programs the robot so that it performs the desired actions required to lead a class to safety in an emergency situation. (Technologies).
Equipment required	**For the class:** Equipment for chance activity e.g., spinners, hats, pop sticks, cards etc. A3 laminating pouches
	For the students: A3 paper Map of the school

Preparation	If time permits, create an example of the grid and run a demonstration to enable students to see the end product. If necessary, familiarize yourself with using the robots of choice. Alternatively, you may wish to invite an expert in to help with this. Familiarise students with robots prior to lesson. Content and activities will depend on what robots are available. Most come with user guides or 'how to' tutorials which can be found on *YouTube*. This is a good opportunity to practice flipped learning and develop peer to peer tutoring as students are naturally curious about this content. Ensure robots are charged.
Activity parts	**Part 1:** Explain to the students they will be planning how to use an evacuation robot to safely guide a class of students from their classroom to a muster point away from buildings in the event of an emergency. Using the mathematical concept of chance, students are allocated a disaster and location where the disaster has taken place. Strategies such as a spinner, options drawn from a hat, written on pop-sticks, cards or dice can be used to allocate disasters and locations to groups. For elaboration and examples see *Teacher resource sheet 2.1*: *Chance processes*. To focus on the mathematical concepts of chance and probability students should not choose their own disaster or location. They work together to represent each of the probabilities, disaster and location, as fractions.
	Part 2: Students analyse a scaled map of the school buildings and grounds. This map can be taken from the school diary or printed from the school website. However, using Google Earth is recommended. If available, students can use their school drone to take an aerial photograph of the school. Suggest to the students that pre-printed maps can contain errors which have not been identified – giving opportunity to develop critical thinking skills.

Students investigate and justify the best evacuation route for their group's scenario.

Students design and create a grid reference map of their school, ensuring they show all areas relevant to their evacuation route from their scenario to the muster point. Suggestions on how to do this can be found in *Teacher resource sheet 2.3 Grid references.*

The map students create should be designed to a size which fits the size and movements of the chosen robot.

Please see *Teacher resource sheet 2.2 Map scaling* for suggestions.

Part 3:

Students program their robot using the method unique to their robot. They can represent this using arrows on grid paper eg, if they wanted the robot to move forward three spaces and turn right it would look like

↑ ↑ ↑ →

They test and refine the code, repeating this process until the robot makes it safely to the evacuation point.

Part 4:

Students work together to video the robot making the journey from their location to the muster point on their grid reference map.

To elaborate on the mathematics curriculum, *Location and transformation* students could also record the map coordinates their robot follows.

Students use a program such as *Explain everything, Puppet pals* or *iMovie* to record a voice over for the video explaining the process, the disaster, route the robot travelled and justify their choices using scientific and mathematical language.

Part 5:

Students write a narrative to match the movements of their robot. The purpose of this is for sharing in *Activity 4*; where people from outside the group read the story and try to program the robot to match.

	Part 6: Teachers conduct a whole class discussion to review the lesson.
	Part 7: Students will continue blogging about their learning and upload their video with voice over from *Part 4*.
Resource sheets	*Teacher resource sheet 2.1*: *Chance processes*. *Teacher resource sheet 2.2: Map scaling* *Teacher resource sheet 2.3 Grid references.*

Activity 3: What is the digital solution?

Activity focus	Students design an evacuation solution represented as an algorithm and transfer this to a simple programming platform such as *Scratch*. Students update their blog with results of the algorithm design process.
Teacher background information about content and disciplinary processes	An algorithm is a sequence of steps that is followed to solve a problem. People use algorithms every day to solve problems and complete tasks, for example baking a cake, or getting dressed. A flowchart is a diagrammatic representation of an algorithm. A flowchart can take the form of a branching set of shapes, with decision-making steps. The shapes used in a flowchart are shown in *Teacher resource sheet 3.1: Flowcharting symbols* and an example of flowchart examples is shown in *Teacher resource sheet 3.2 Flowchart example*. In its most developed form, an algorithm can be converted to computer code, or generalised with a mathematical model. Such computer code could be in Scratch, a software platform that allows students to use block based programming to code. This activity will allow students to engage in the process of computational thinking and block based coding by creating an animation using content they have learned.
Learning outcomes	Students will be able to: 1. Identify an escape route and designs a flowchart that can be used as an algorithm as the basis for programing a robot (Technologies). 2. Use coding software to simulate an evacuation route.
Equipment required	**For the class:** Smartboard or data projector to show videos. Scratch / Scratch Jnr Laptops / iPads / tablets

	For the students: Devices for programming Map of the school Butchers paper or A3 paper.
Preparation	Familiarise yourself with flowcharting and Scratch using the digital resources. Students may wish to preview Scratch and familiarise themselves with the program prior to the lesson. Download the videos to minimise streaming issues. Provide access to laptops / iPads / tablets.
Activity parts	**Part 1:** Students continue to work in the same small groups from the previous activity and work on the same disaster and location allocated to their group in *Activity 2*. Explain that students will create a flowchart to represent their algorithm which could be used to program a robot.
	Part 2: Discuss the meaning of an algorithm and flowchart. Relate this to the scenario in everyday life of buying a new pair of red shoes. Using the example in *Teacher resource sheet 3.2: Flowchart examples*, discuss how to alter an algorithm based on different scenarios. Discussion questions may include: how would you change the algorithm if you could only spend $80? Can you extend the algorithm to consider shoe size? Watch the video from the *Khan Academy, What is an algorithm and why should you care?* Another option is to watch the video from *The Big Bang Theory*, *The Friendship Algorithm*. See the digital resource list for references. Explain the meaning of the shapes and flowlines that make up the flowchart of an algorithm. The basic shapes are shown in *Teacher resource sheet 3.1: Flowcharting symbols*. A full set of flowcharting symbols are available in *MS Word* using the 'Insert – Shapes' function.

Part 3:

To develop algorithmic thinking students consider different escape routes to safely evacuate the class from their location to muster point using the grid reference map of the school from *Activity 2* to plan.

Note: The purpose of the second example on *Teacher resource sheet 3.2: Flowchart examples* is to provide teachers with an example of this task. As there are many solutions it is recommended not to show this to the students until after they have worked out their own solution.

Students identify three or four possible routes from their location with key forks or decisions to make along the way towards the muster point. Students select the best path based on whether there is a threat or not, i.e., choosing to turn left or right based on whether there is a fire or not. They use a flowchart to represent the best escape route as an algorithm.

When creating their emergency evacuation route, factors that may influence their choice include:

- Distance, air flow, accessibility and congestion
- Blocked passages – how robots detect / adjust for a blocked pathway
- Uneven surfaces – are there pathways through the school that are not suitable for people with crutches or in wheelchairs? Plot a path / create an algorithm that first asks what capabilities students have / what needs they have that then impact on the algorithm's choices
- Avoiding fire – how do robots detect fire? Can they be made to use their sensors to then detect and respond to light or heat?
- Make an advanced scout – can the robot be made to speak? Can it issue commands to the people it is leading, telling them to wait while it goes ahead and scouts for the best path before returning to collect them – think of a robot peering around a corner and seeing and coming back before leading a group into danger

Provide feedback to groups to enhance collaboration and pose questions to stimulate problem solving. Use 'why' questions and 'because' prompts to stimulate reasoning and justification of answers.

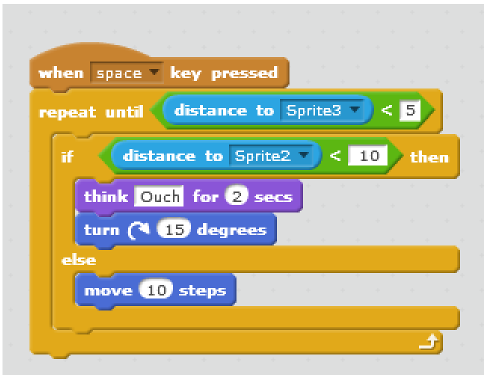
- Why is this the best escape route? … Because?
- What would happen if…?

Ask groups to share their thinking with the class and encourage other groups to provide verbal feedback to develop peer mentoring.

Part 5:

Using information from Part 3 students create an animation using visual programming software, such as *Scratch*. This animation will show information about the evacuation in the form of a search and rescue, emergency response or other robot or drone focused game.

The image shows what coding the flowchart in scratch may look like and makes images (sprites) in another screen move in response to fire.



Story Board

Students work collaboratively to storyboard their animation using the provided worksheet (*Student activity sheet 3.3: Animation – Story Boarding*) to sketch out the backgrounds, sprites and dialogue.

Animation (Scratch)

Using the Storyboard as a reference, students use *Scratch* or *Scratch Jnr* to create an animation showing the evacuation route and disaster. The animation should include appropriate sprites, backgrounds, music and dialogue.

Part 6:

Using an interactive whiteboard the teacher invites selected groups to share their scratch programs.

	Part 7: Students update their blog explaining the design process.
Resource sheets	*Teacher resource sheet 3.1: Flowcharting symbols* *Teacher resource sheet 3.2: Flowchart example* *Student activity sheet 3.3: Animation – Story Boarding*
Digital resources	Scratch Software https://scratch.mit.edu/
	Scratch Jnr (iPads) https://www.scratchjr.org/
	Scratch: Instructional Videos https://scratch.mit.edu/help/videos/
	Khan Academy, *What is an algorithm and why should you care?* www.khanacademy.org/computing/computer-science/algorithms/intro-to-algorithms/v/what-are-algorithms
	The Big Bang Theory – *The Friendship Algorithm* www.youtube.com/watch?v=k0xgjUhEG3U
	Algorithms: *Plugged & Unplugged* docs.google.com/presentation/d/1K-6F3yYRf2lkwkU1C2-yLxveV9Zt8RtyrVBfEzB0qS8/edit#slide=id.g13ec2dcc77_1_67
	Algorithm definition and pictorial example www.tynker.com/blog/articles/ideas-and-tips/how-to-explain-algorithms-to-kids/
	Legend of symbols used in algorithm 1.bp.blogspot.com/_-n5ew-cmW7o/TU6u0Mt768I/AAAAAAAAAIE/9PB0Vy0BeJU/s1600/flowchart-symbols.gif

Activity 4: Let's pitch our solution

Activity focus	Students present their robot evacuation solution in groups to an audience beyond the classroom.
Teacher background information about instructional procedures	Students may need information about effective presentation skills such as voice clarity and projection, volume, pitch and tone. Time constraints should be set for presentations and all students should have an opportunity to speak. Students will need support and scaffolding to help them prepare for their presentation. To scaffold cooperative group work, each member of the group could have a role and responsibility. For example, one could be the content director, one the media director and a third the presentation director. The presentations will provide a rich opportunity for assessing the students understanding of the mathematics and technology principles and processes, as well as the literacies associated with speaking and listening. Digital options include creating a comic strip, *eBook*, poster in *Pages*, *Keynote* or *PowerPoint* or simple *iMovie* (or similar), which will then be shared through a digital portfolio platform such as *Seesaw* or *Class Dojo*, or added to the class blog, or shared on the interactive whiteboard. Students may require explicit instruction in using these apps.
Learning outcomes	Students will be able to: 1. Use digital technologies to organise and present information about the design and the design process (Technologies). 2. Work collaboratively to plan, develop and communicate ideas and information for solutions (Technologies)
Equipment required	**For the class:** Interactive whiteboard or data projector. Multimedia specific to students' presentation requirements.

	For the students: Digital devices loaded with appropriate apps for multimedia presentations. *Student activity sheet 4.1: Peer evaluation*
Preparation	Ensure technology and media are available. Invite a local community expert, for example a firefighter or SES volunteer, to view the final presentations.
Activity parts	**Part 1:** Explain to students they will make a multimedia presentation to describe their work from *Activity 2* and *3* including their flowchart, share their evacuation robot video, justify its design and effectiveness, and highlight options for further enhancements.
	Part 2: Making the presentation: It is assumed that presentations will be made by groups. If the group size is three or four there may be eight to ten groups which means the presentations may have to be scheduled for two separate sessions. • How long will the presentations be? Perhaps five minutes with two minutes for questions and two minutes swap over between groups (ie, nine to ten minutes per group). • Who will speak? One person might introduce the presentation, another give the presentation and a third answer any questions.
	Part 3: Students should provide peer feedback on group work skills using the *Student activity sheet 4.1: Peer evaluation*. If possible, students should test and review each algorithm design, leaving notes for the group. A 3–2–1 strategy would work well; where students identify 3 things they discovered, 2 things they found interesting and 1 question they still have for the group. Feedback could be recorded on a printed copy of the algorithm or added to blogs.

	Part 4: Students should reflect on feedback and the overall process, recording thoughts on their blogs.
Resource sheets	*Student activity sheet 4.1: Peer evaluation*
Digital resources	Comic Life itunes.apple.com/us/app/comic-life/id432537882?mt=8&ign-mpt=uo%3D4 ($4.99)
	Comic Maker HD bugunsoft.com/comicmakerhd
	iBooks Author www.apple.com/au/ibooks-author/
	Book Creator bookcreator.com
	iMovie itunes.apple.com/au/app/imovie/id377298193?mt=8
	Pages itunes.apple.com/au/app/pages/id361309726?mt=8
	Keynote itunes.apple.com/au/app/keynote/id361285480?mt=8
	Seesaw Digital Portfolio web.seesaw.me/
	Class Dojo www.classdojo.com/
	eBook www.ebooks.com/
	Scratch www.scratch.mit.edu splash.abc.net.au/home#!/digibook/2427023/introduction-to-scratch

Appendix 1: Assessment rubric

Science:

	A **Excellent achievement** The student demonstrates **excellent achievement** of what is expected for this year level	B **High achievement** The student demonstrates **high achievement** of what is expected for this year level	C **Satisfactory achievement** The student demonstrates **satisfactory achievement** of what is expected for this year level	D **Limited achievement** The student demonstrates **limited achievement** of what is expected for this year level	E **Very low achievement** The student demonstrates **very low achievement** of what is expected for this year level
Science as a human endeavor					
Use and influence of science	**Content description:** *Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)*		**Learning outcome:** Explain what a robot is and how robots can improve our lives by assisting us. Design a solution to inform people of the best evacuation route in the event of an emergency.		**Activities** Activities 1 & 3
	Identifies the emergency situation and explains how the solution design will help inform people, justifying methods used.	Identifies the emergency situation, designs a simple solution and explains how the solution design will help inform people.	Designs a simple solution to inform people in response to a given emergency situation.	Finds it difficult to independently design a solution to inform people in response to an emergency situation.	Does not meet the requirements of a D grade

Technologies:

	A **Excellent achievement** The student demonstrates **excellent achievement** of what is expected for this year level	B **High achievement** The student demonstrates **high achievement** of what is expected for this year level	C **Satisfactory achievement** The student demonstrates **satisfactory achievement** of what is expected for this year level	D **Limited achievement** The student demonstrates **limited achievement** of what is expected for this year level	E **Very low achievement** The student demonstrates **very low achievement** of what is expected for this year level
Digital Technologies: Process and production skills					
Digital implementation	**Content description:** *Design, follow and represent diagrammatically, a simple sequence of steps (algorithm), involving branching (decisions) and iteration (repetition) (ACTDIP019)*		**Learning outcome:** Identifies an escape route and designs a flowchart that can be used as an algorithm as the basis for programing a robot		**Activities** Activity 3
	Designs, clearly represents diagrammatically and explains a complex sequence of steps (algorithms), involving branching (decisions) and iteration (repetition)	Designs and represents diagrammatically, a simple sequence of steps (algorithms), involving branching (decisions) and iteration (repetition).	Identifies an escape route and plans the main sequence of steps to be followed.	Identifies an escape route and provides a simple diagrammatic representation of it.	Does not meet the requirements of a D grade
	Implement and use simple programming environments that include branching (decisions) and iteration (repetition) (ACTDIP020)		Documents programming instructions in a systematic way, and successfully programs the robot so that it performs the desired actions required to lead a class to safety in an emergency situation.		Activities 2 & 3

	Develops, clearly communicates and justifies alternative solutions, and uses clearly annotated diagrams, storyboards and a range of appropriate technical terms when following design ideas.	Develops and clearly communicates alternative solutions, and uses clearly annotated diagrams, storyboards and appropriate technical terms when following design ideas.	Develops and communicates alternative solutions, and uses annotated diagrams, storyboards and appropriate technical terms when following design ideas.	Follows basic design ideas, using simple diagrams or storyboards with few technical terms.	Does not meet the requirements of a D grade
Collaborating and managing	*Work independently, or collaboratively when required, to plan, develop and communicate ideas and information for solutions*		Work collaboratively to plan, develop and communicate ideas and information for solutions.		Activities: 1, 2, 3 & 4
	Provides leadership to the group by facilitating conflict resolution and keeping the group on-task, and acts as an effective collaborator by listening to others, offering suggestions and accepting the views of others	Provides leadership to the group by keeping the group on-task, and acts as an effective collaborator by listening to others and offering suggestions.	Acts as an effective collaborator by listening to others and offering suggestions for solving the problem.	Contributes suggestions for solving the problem	Does not meet the requirements of a D grade
Digital implementation	*Create and communicate information, including online collaborative projects, using agreed social, ethical and technical protocols (codes of conduct) (ACTDIP022)*		Use digital technologies to organise and present information about the design and the design process (Technologies).		Activities 1 to 4
	Creates and clearly communicates information for online collaborative projects, using more than one form of digital media and agreed social, ethical and technical protocols.	Creates and communicates information for online collaborative projects, using more than one form of digital media and agreed social, ethical and technical protocols.	Creates and communicates information for online collaborative projects, using agreed social, ethical and technical protocols.	Creates information for online collaborative projects, using agreed social, ethical and technical protocols.	Does not meet the requirements of a D grade

Mathematics:

	A **Excellent achievement** The student demonstrates **excellent achievement** of what is expected for this year level	B **High achievement** The student demonstrates **high achievement** of what is expected for this year level	C **Satisfactory achievement** The student demonstrates **satisfactory achievement** of what is expected for this year level	D **Limited achievement** The student demonstrates **limited achievement** of what is expected for this year level	E **Very low achievement** The student demonstrates **very low achievement** of what is expected for this year level
			Measurement and Geometry		
Location and transformation	**Content description:** *Use a grid reference system to describe locations. Describe routes using landmarks and directional language (ACMMG113)*		**Learning outcome:** Use the mathematical concepts and language specific to grid reference systems in order to create a map and identify locations at school.		**Activities** Activity 2
	Creates and uses a grid reference system and applies directional language to locate landmarks and describe routes	Uses a grid reference system to locate landmarks and uses directional language to describe routes.	Uses a grid reference system to locate landmarks on a map.	Uses a grid reference system to locate some landmarks on a map.	Does not meet the requirements of a D grade

Statistics and Probability					
Chance	*List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions (ACMSP116)* *Recognise that probabilities range from 0 to 1 (ACMSP117)*		Lists outcomes when looking at disasters and locations in the school and represent probabilities of these using fractions.		Activity 2
	Creates successful chance experiments, predicts all possible outcomes and represents the probabilities between 0 and 1 and uses fractions.	Predicts the outcomes of chance experiments and represents the probabilities between 0 to 1 and uses fractions	Lists the outcomes of chance experiments with equally likely outcomes, and states probabilities between 0 and 1.	List some of the possible outcomes in chance experiments.	Does not meet the requirements of a D grade

Appendix 2: General capabilities continuums

The general capabilities continuums shown here are designed to enable teachers to understand the progression students should make with reference to each of the elements. There is no intention for them to be used for assessment.

ICT capability learning continuum

Sub-element	Typically by the end of Year 4	Typically by the end of Year 6	Typically by the end of Year 8
Create with ICT **Generate ideas, plans and processes**	use ICT to generate ideas and plan solutions	use ICT effectively to record ideas, represent thinking and plan solutions	use appropriate ICT to collaboratively generate ideas and develop plans
Create with ICT **Generate solutions to challenges and learning area tasks**	create and modify simple digital solutions, creative outputs or data representation/ transformation for particular purposes	independently or collaboratively create and modify digital solutions, creative outputs or data representation/transformation for particular audiences and purposes	design and modify simple digital solutions, or multimodal creative outputs or data transformations for particular audiences and purposes following recognised conventions
Communicating with ICT **Collaborate, share and exchange**	use appropriate ICT tools safely to share and exchange information with appropriate known audiences	select and use appropriate ICT tools safely to share and exchange information and to safely collaborate with others	select and use appropriate ICT tools safely to lead groups in sharing and exchanging information, and taking part in online projects or active collaborations with appropriate global audiences

Critical and creative thinking learning continuum

Sub-element	Typically by the end of Year 4	Typically by the end of Year 6	Typically by the end of Year 8
Inquiring – identifying, exploring and organising information and ideas **Organise and process information**	collect, compare and categorise facts and opinions found in a widening range of sources	analyse, condense and combine relevant information from multiple sources	critically analyse information and evidence according to criteria such as validity and relevance
Generating ideas, possibilities and actions **Imagine possibilities and connect ideas**	expand on known ideas to create new and imaginative combinations	combine ideas in a variety of ways and from a range of sources to create new possibilities	draw parallels between known and new ideas to create new ways of achieving goals
Generating ideas, possibilities and actions **Seek solutions and put ideas into action**	experiment with a range of options when seeking solutions and putting ideas into action	assess and test options to identify the most effective solution and to put ideas into action	predict possibilities, and identify and test consequences when seeking solutions and putting ideas into action
Reflecting on thinking and processes **Transfer knowledge into new contexts**	transfer and apply information in one setting to enrich another	apply knowledge gained from one context to another unrelated context and identify new meaning	justify reasons for decisions when transferring information to similar and different contexts

Personal and social capability learning continuum

Sub-element	Typically by the end of Year 4	Typically by the end of Year 6	Typically by the end of Year 8
Social management **Work collaboratively**	describe characteristics of cooperative behaviour and identify evidence of these in group activities	contribute to groups and teams, suggesting improvements in methods used for group investigations and projects	assess the extent to which individual roles and responsibilities enhance group cohesion and the achievement of personal and group objectives
Social management **Negotiate and resolve conflict**	identify a range of conflict resolution strategies to negotiate positive outcomes to problems	identify causes and effects of conflict, and practise different strategies to diffuse or resolve conflict situations	assess the appropriateness of various conflict resolution strategies in a range of social and work-related situations
Social management **Develop leadership skills**	initiate or help to organise group activities that address a common need	initiate or help to organise group activities that address a common need	plan school and community projects, applying effective problem-solving and team-building strategies, and making the most of available resources to achieve goals

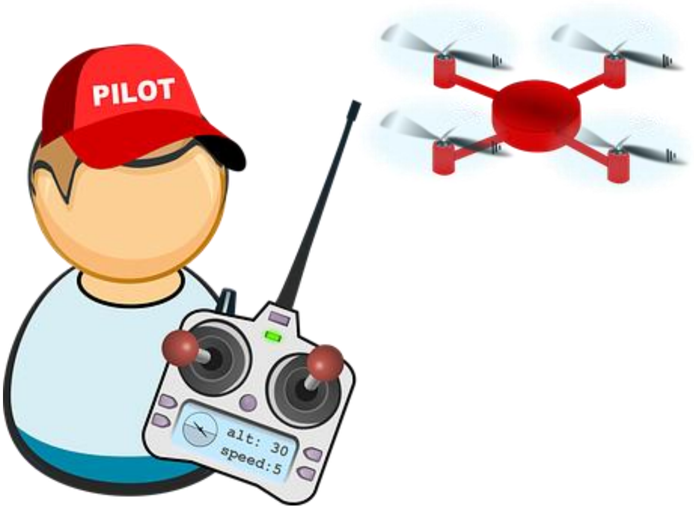
Access to this information is via the link here:
k10outline.scsa.wa.edu.au/home/p-10-curriculum/general-capabilities-over/general-capabilities-overview/general-capabilities-in-the-australian-curriculum

Appendix 3: Materials list

You will need the following materials to complete this module.

- Robots – where possible each group should have access to a robot; groups could use different robots or the class could share one robot. Note; if sharing then *Activity 3* is best completed in small group rotations.

- Perspex or A3 laminating pouches



Appendix 4: Design process guide

Research

Finding useful and helpful information about the design problem.

Gathering information, conducting surveys, finding examples of existing solutions, testing properties of materials, practical testing.

Analysis

Understanding the meaning of the research findings.

Analysing what the information means, summarising the surveys, judging the value of existing solutions, understanding test results.

Ideation

Idea generation – turning ideas into tangible forms so that they can be organised, ordered and communicated to others.

Activities such as brainstorming, mind mapping, sketching, drawing diagrams and plans, collecting colour samples and/or material samples and talking through these ideas can help to generate more creative ideas.

Using the **SCAMPER** model can assist with this:
www.mindtools.com/pages/article/newCT_02.htm

www.designorate.com/a-guide-to-the-scamper-technique-for-creative-thinking/

Development

Development of the design ideas. Improvements, refinements, adding detail, making it better.

Activities such as detailed drawings, modelling, prototyping, market research, gaining feedback from intended user, further research – if needed – to solve an issue with the design, testing out different tools or equipment, trialling production processes, working out dimensions, testing of prototypes and further refinement.

Production

Safe production of the final design or multiple copies of the final design.

Fine tuning the production process, such as division of labour for batch or mass production.

Use of intended materials and appropriate tools to safely make the solution to the design problem.

Evaluation

Reflection on the process taken and the success of the design.

Evaluation can lead into further development or improvement of the design and can be a final stage of the design process before a conclusion is reached.

Could be formal or informal and verbal or written.

Appendix 5: Reflective journal

When students reflect on learning and analyse their own ideas and feelings, they self-evaluate, improving metacognitive skills.

These modules encourage students to self-reflect and record the stages of their learning in a journal. This journal may take the form of a written journal, a portfolio or a digital portfolio.

Digital portfolios address the Digital Technologies curriculum content description, *Manage the creation and communication of information, including online collaborative projects, using agreed social, ethical and technical protocols (ACTDIP022).*

Reflective practice and recording can be supported in classrooms by creating opportunities for students to think about and record their learning through notes, drawings or pictures. Teachers should encourage students to revisit earlier journal entries to help them observe the progression of their thoughts and understanding.

Journals become a useful assessment tool that gives teachers additional insight into how students value their own learning and progress, as well as visually demonstrating their individual achievements.

The following links give background and useful applications for journaling.

Reflective journals www.uts.edu.au/sites/default/files/reflective_journal.pdf
Reflective thinking www.ais.sa.edu.au/__files/f/173001/AISSA%20Reflective%20Thinking.pdf
Balancing learning with accountability electronicportfolios.org/balance/Balancing.jpg
Digital portfolios cooltoolsforschool.wordpress.com/digital-student-portfolios/
Kidblog – digital portfolios and blogging kidblog.org/home/
Evernote (a digital portfolio app) evernote.com/
Weebly for education (a drag and drop website builder) education.weebly.com/

Appendix 6: Teacher resource sheet 1.1: Cooperative learning – Roles

Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can fulfil part of the Western Australian Curriculum General Capability: Personal and social capability.

When students are working within groups, positive interdependence can be fostered by assigning roles to various group members.

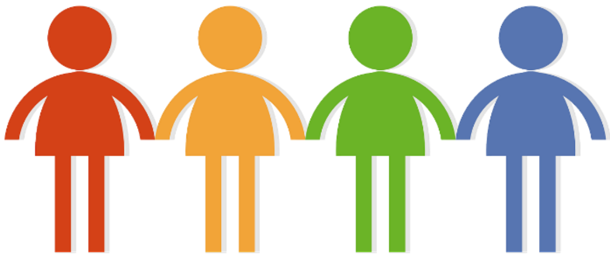
These roles could include:

- working roles such as Timekeeper, Resources, Reader, Writer, Artist, Planner
- social roles such as Motivator, Noise monitor, Observer.

Teachers using the *Primary Connections* roles of Director, Manager and Speaker for their science teaching may find it effective to also use these roles for STEM learning.

Further to this, specific roles can be delineated for specific activities that the group is completing.

It can help students if some background to the purpose of group roles is made clear to them before they start, but at no time should the roles get in the way of the learning. Roles may not always be appropriate in given tasks and the decision rests with the teacher.



Appendix 7: Teacher resource sheet 1.2: Cooperative learning – Jigsaw

This resource sheet provides a brief outline of a collaborative learning strategy known as the 'jigsaw' method.

Cooperative learning frameworks create opportunities for groups of students to work together, generally for a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can fulfil part of the Western Australian Curriculum General Capability: Personal and social capability.

The jigsaw method involves group work and typically has each member of the group becoming 'experts' on one or two aspects of a topic or question being investigated. Students start in their groups then break away to join 'experts' from the other groups to investigate and learn about a specific aspect of a topic. After developing a sound level of understanding, the students return to their groups and teach each other what they have learnt.

Within each expert group, issues such as how to teach the information to their group members are considered.

Step 1	**Cooperative groups** (of four students)	**1 2 3 4**		**1 2 3 4**	
Step 2	**Expert groups** (size equal to the number of groups)	**1 1**	**2 2**	**3 3**	**4 4**
Step 3	**Cooperative groups** (of four students)	**1 2 3 4**		**1 2 3 4**	

The diagram here shows two initial groups of four students. The first student from each group forms an expert group of 1s. The second student from each group forms an expert group of 2s, and so on. After learning their assigned material, these students from the expert group return to their cooperative groups to teach others.

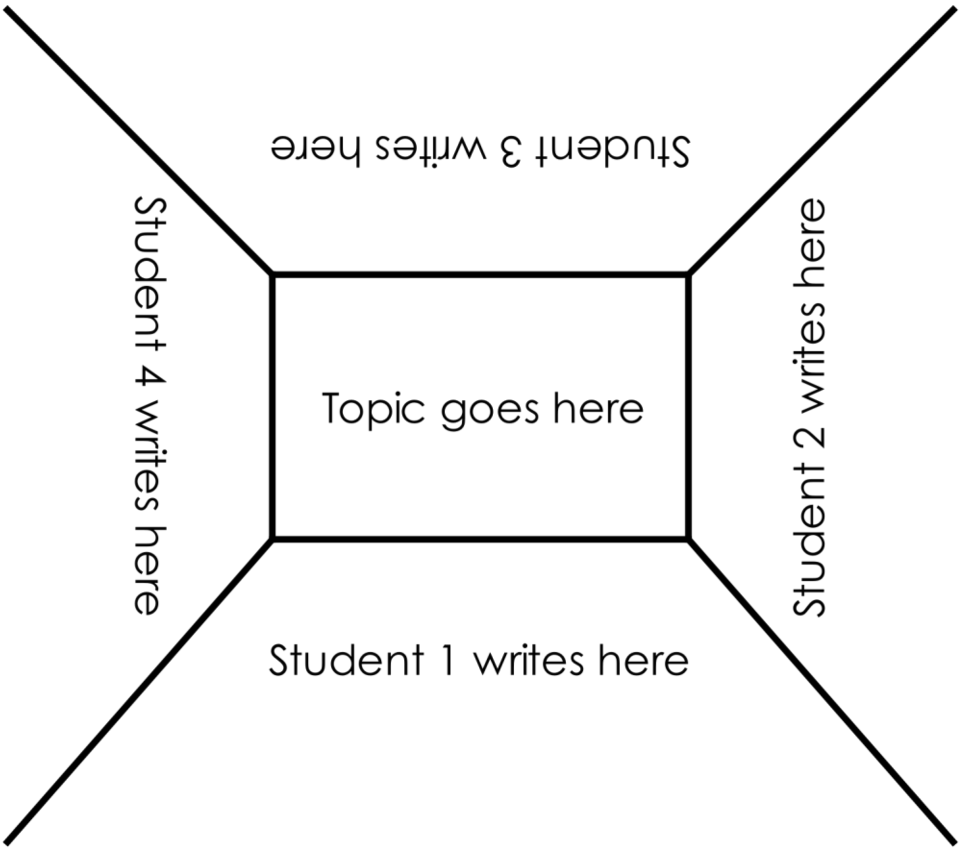
Appendix 8: Teacher resource sheet 1.3: Cooperative learning – Placemat

This resource sheet provides a brief outline on a cooperative learning technique known as 'placemat'.

Cooperative learning frameworks create opportunities for groups of students to work together, generally for a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can fulfil part of the Western Australian Curriculum General Capability: Personal and social capability.

The placemat method involves students working collaboratively to record prior knowledge about a common topic, brainstorm an idea or similar. It also allows teachers to readily see the contribution of each individual student. The diagram below shows how this is set out for students.



Appendix 9: Teacher resource sheet 1.4: Cooperative learning – Think, Pair, Share

This resource sheet provides a brief outline on a collaborative learning technique known as 'think – pair – share'.

Cooperative learning frameworks create opportunities for groups of students to work together, generally to a single purpose.

As well as having the potential to increase learning for all students involved, using these frameworks can fulfil part of the Western Australian Curriculum General Capability: Personal and social capability.

In the 'think' stage, each student thinks silently about a question asked by the teacher.

In the 'pair' stage, students are paired up to discuss their thoughts and answers to the question.

In the 'share' stage, the students share their answer, their partners answer or what they decided together. This sharing may be with other pairs or with the whole class. It is important also to let students 'pass'. This is a key element of making the technique safe for students.

Think – pair – share increases student participation and provides an environment for higher levels of thinking and questioning.

Appendix 10: Teacher resource sheet 2.1: Chance processes

Content description:

- List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions (ACMSP116).

This resource sheet provides information on how to consolidate the above chance outcome, through the random selection of disasters and room locations.

Background:

The key underlying principle of chance processes is the concept of equally likely outcomes.

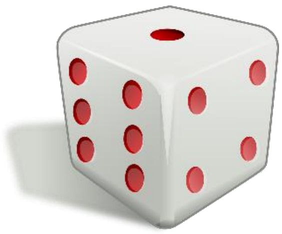
Initially for this Activity, the outcomes should be considered equally likely. As such, the simulation must have equally likely outcomes. There are two aspects of the evacuation that can be randomised, the disaster and the room to evacuate[#1].

For example:

Using the following possible list of five disasters:

Fire, flood, earthquake, chemical spill, and gas leak[#2].

A chance process to simulate the "selection" of one of these disasters is the rolling of a single six-sided die – which has equally likely outcomes. Hence, matching each disaster type with a number on the die is appropriate. The fact that the die has an "extra" side which is unmatched makes no difference. If this unmatched side is rolled, simply roll again[#3]



From the following possible list of room numbers:

1, 2, 3, 4, 5 . . . 14, 15, and 16[#4].

A chance process to simulate the "selection" of one of these rooms needs to give each room an equally likely chance of being selected.

A simple way of doing is to put the numbers 1 to 16 on equally sized pieces of paper and draw them sight unseen from a "hat"[#5].

Another option is to make two spinners[#6]. The first spinner representing the tens digit of the room number could have two equal sections of 180° [#7] marked 0 and 1. The second spinner representing the ones digit of the room number should have ten equal sections of 36°. If a room number that does not exist is spun (eg, 19), simply spin again.

An example of procedure:

Each group rolls the die to find out what disaster they have to evacuate from.

They then spin the two spinners (or pick from the hat) to determine what room they need to evacuate.

Notes:

1: It is possible to randomly allocate a location for each disaster. However, it may be simpler to decide this in advance eg, the chemical spill is at the cleaner's storeroom.

2: Teachers need to review what disasters they will use with their class and select an appropriate list.

3: Dice with various numbers of equally likely sides are available, it is useful to learn the idea of not using one side. It is better to vary the types of randomising tools as much as possible eg, dice, spinners, coins, cards etc.

4: Numbering may vary from school to school and hence teachers need to adapt this to suit their situation.

5: Emphasise for students the equal size and sight unseen factors, which will help develop their understanding of a fair experiment, with equally likely outcomes. To retain the chance of each room being equally likely for each group, the drawn numbers should be replaced after each draw. If they are not replaced, the chance process is more complex.

6: Googling "making a spinner" will give you various ways of doing this. Making an appropriate spinner helps students with their understanding of chance.

7: As a full circle is 360°, each section should be 360° ÷ the number of sections. Being equal sized ensures outcomes are equally likely.

Appendix 11: Teacher resource sheet 2.2 Map scaling

Content description:

- Use a grid reference system to describe locations. Describe routes using landmarks and directional language (ACMMG113)

This resource sheet provides information on how to:

- assist students with the selection of an appropriate scale
- work with robot specifications in relation to maps and scaling

Mapping robot movements

A Bee-Bot and an Edison robot have a standard step distance of 15 cm.

If using these robots, students should create a grid reference map using 15 cm^2 squares; refer to *Teacher resource sheet 2.3: Grid references* for elaborations on grid referencing.

Choosing map scales – if you intend using a scaled map of the school in place of a grid reference.

At this year level a map scale of 1 m = 1 cm or 100:1 is an appropriate and simple scale to use for map drawing around the school.

If using an A4 sheet of cm^2 grid paper, the grid will usually be about 25 cm by 20 cm with clear margins around the grid. With a 100:1 scale this will allow for measurements up to 25 m by 20 m enough for a classroom, or a few classrooms, but not usually enough to map a school.

If a school site measures for example 400 m by 400 m, then a 100:1 scale will require paper 4 m by 4 m. An alternative is to use a different scale.

Using a scale of 1000:1 the 400 m by 400 m school site will draw up as a 40 cm by 40 cm map. This would fit well on an A3 grid sheet (or two pieces of A4 joined together.)

A scale of 1000:1 ie equivalent to 10 m = 1 cm.

If a map is drawn of the school using a scale of 1000:1 then this will mean that each robotic step of the Edison/Bee-bot will be equivalent to 1000 lots of 15 cm or 150 m steps!!!!

Appendix 12: Teacher resource sheet 2.3: Grid references

Content description

- Use a grid reference system to describe locations. Describe routes using landmarks and directional language (ACMMG113)

This resource sheet provides information on how to create a grid as a representation of the school grounds for students to use when programming robots.

Dimensions for the grid have been recommended using *Edisons* and *Bee-Bots* as an example. As these robots move in 15cm blocks an ideal grid to fit on an A2 sheet (two A3 sheets) would be 60 cm x 75 cm, with each box measuring 15 cm x 15 cm.

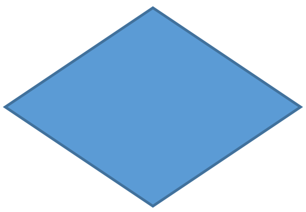
This creates a five by four grid as illustrated in the example. The axis will need to be labelled as shown, as well as the start and end points, and disaster.

Students plot places around the school using grid referencing to identify locations and a key to identify buildings. Thumbnail photos or student sketches can be used to represent the buildings. Note the buildings and areas do not need to be to scale. Assume buildings and space fill whole grid squares.

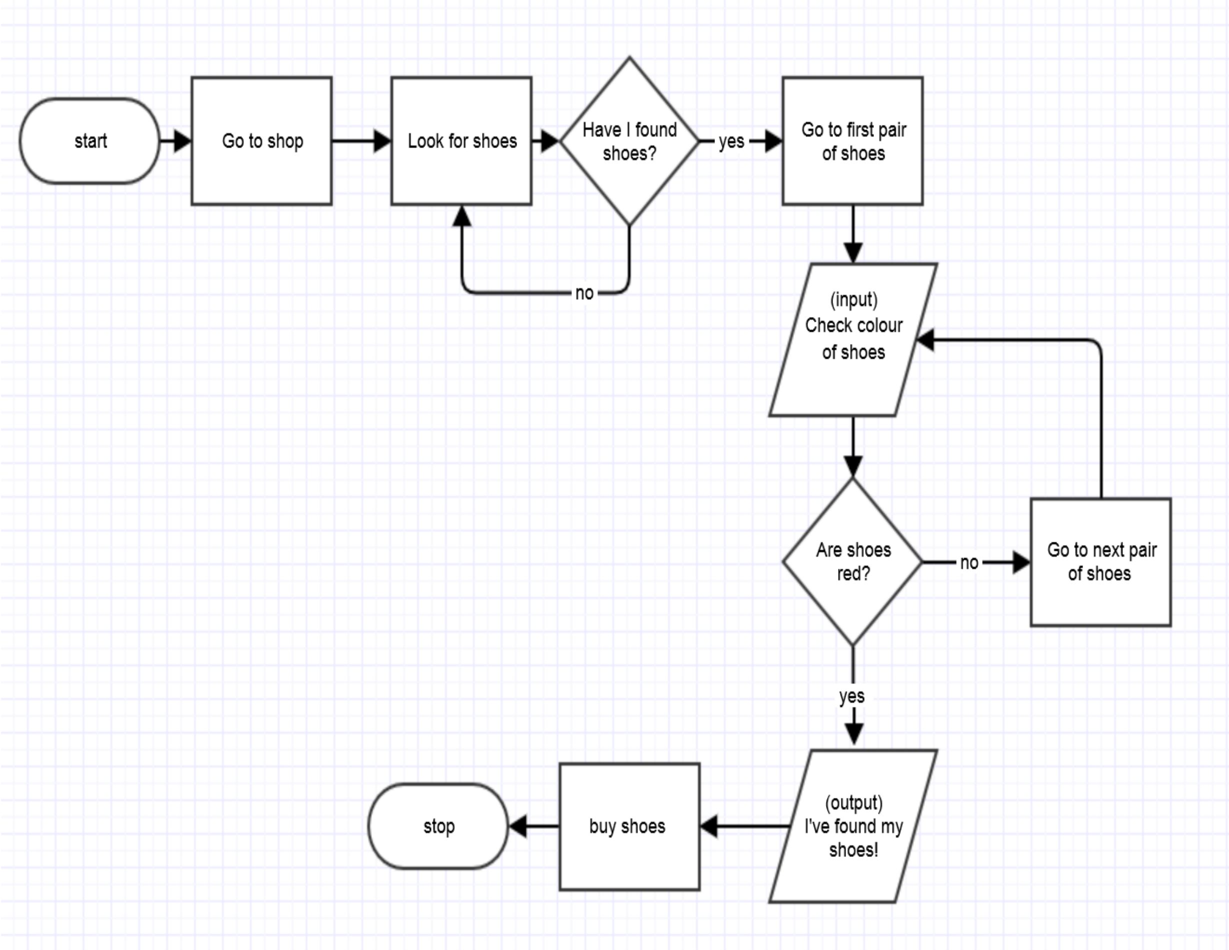
The fire can be seen at (C, 3), if the class were located at (A, 3) and the muster point (E, 1) students need to describe routes for their robot to follow using landmarks, directional language and grid references.

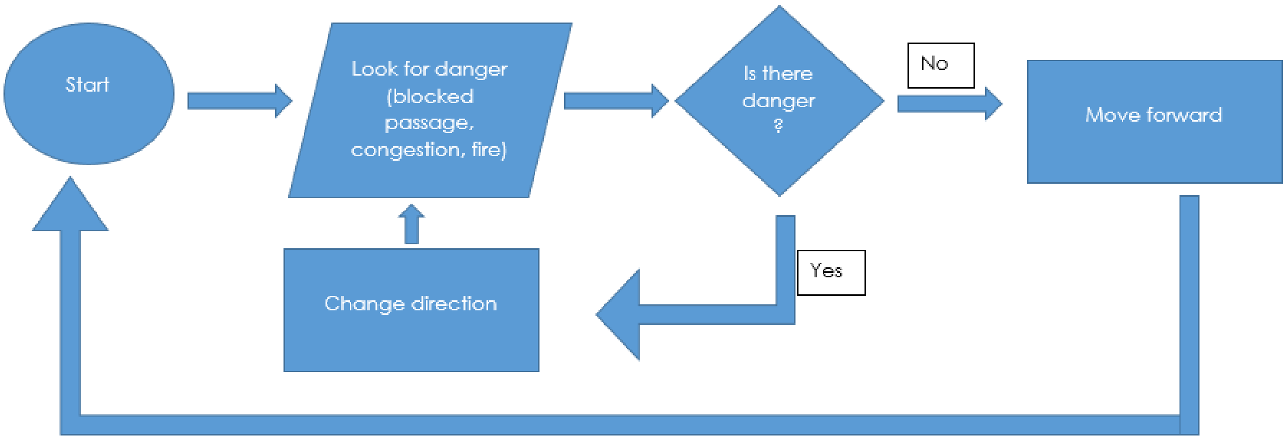
Appendix 13: Teacher resource sheet 3.1: Flowcharting symbols

A flowchart is a diagrammatic representation of an algorithm. It can take the form of a branching set of shapes, with decision-making steps. The shapes used in a flowchart are shown here, with explanations of their purpose.

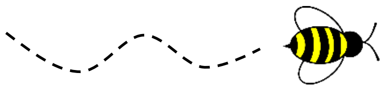
	**Terminator** This symbol is used to represent the start and end of a flowchart.
	**Process** This symbol is used to represent one or more instructions, or things to do.
	**Data** This symbol is used to represent the input or output of any information.
	**Decision** This symbol is used to represent a point in the flowchart where a decision is made, and from which two or more paths could be followed.
	**Flowline** This symbol is used to show the direction of the process, or data flow.

Appendix 14: Teacher resource sheet 3.2: Flowchart examples





Appendix 15: Student activity sheet 3.3: Animation - Story Boarding



Scene 1

Scene 2

Scene 3

Sprites / Backgrounds

Music / FX

Appendix 16: Student activity sheet 4.1: Peer evaluation

	4	3	2	1	0
	Excellent/ Independently and consistently	**Very good/ Consistently**	**Satisfactory/ Usually**	**Needs attention/ Sometimes**	**Unacceptable/ Rarely**
Remains focused on tasks presented					
Completes set tasks to best of their ability					
Works independently without disrupting others					
Manages time effectively					
Cooperates effectively within the group					
Contributes to group discussions					
Shows respect and consideration for others					
Uses appropriate conflict resolution skills					
Actively seeks and uses feedback					

Comments:

____

____Score: /36

Notes