STEM Stage 1 | Science and Technology, Mathematics | *Coding a dance sequence*

Summary

In this unit students use skills in Working Technologically to develop ideas about engineering, coding and a design process. They use the scientific skills of observing, questioning, predicting and communicating and use mathematical skills in patterns and algebra, and data, to analyse the effectiveness of their design solutions. They explore the use of patterns to develop a code for a dance sequence and begin to use Scratch Jr. Students also investigate the role of scientists and engineers in society.

Duration

7 weeks

1.5–2.5 hours a week

Teacher background information

The focus of this unit is for students to use a design process to develop a repeated coding pattern and to program it using *Scratch Jr*. When Working Scientifically, students identify questions, make predictions and investigate everyday phenomena. When Working Technologically, students are guided with a structured design process that includes the opportunities to produce a solution in response to a need. Students generate and develop design ideas using their own research to guide their design solution. They communicate their design ideas using plans, drawings and models.

For students to fully understand and appreciate the concept of patterning and to search for, generate and create patterns, they must be given opportunities to explore both the regularity and repetition in patterns involving movement, colour, position and quantity. This involves students recognising, describing, extending, transferring and creating patterns. By providing experiences which extend and modify pre-existing knowledge, students are better able to construct meaning and build understanding, which can be applied to new situations such as generating simple algorithms or computer code. Patterns are the basis for computer coding and how all programmable devices work. These links should be made apparent to students throughout the unit by highlighting connections to devices that can be found in the classroom and in the students' homes, such as computers or tablet devices.

To facilitate effective STEM teaching and learning, it is important to develop a class culture that accepts mistakes, encourages innovation, has an improvement perspective and is able to give and receive constructive feedback.

Resources overview

- *Engibear's Dream* by Andrew King and Benjamin Johnston
- Grid paper
- YouTube video: *Austin's Butterfly* (6 min 18 s)
- Computer/tablet
- Scratch Jnr (app)
- YouTube video of a RoboCup Dance competition
- Another free coding app, such as
  - Daisy the Dinosaur by Hopscotch Technologies
  - Move The Turtle - http://movetheturtle.com/
  - Cargo-Bot by Two Lives Left - http://twolivesleft.com/CargoBot/
- Optional:
  - Bee-Bots (or other simple programmable robot)
  - *Hello Ruby* by Linda Liukas

Key inquiry questions

- What is a design process? How do engineers use the design process?
- What are some examples of technology that we use to make our lives better (eg easier, faster)?
- What is an algorithm and how do we use them with digital technology, such as Scratch Jnr or Bee-Bots?

Vocabulary

algorithm, angles, coding, communicate, compare, computer, design, engineer, error, evaluate, experiment, feedback, graph paper, horizontal, imagery, invention, label, length, linking chain, measure, modify, observe, pattern, predict, process, prototype, question, refine, repeated, retest, robot, scientist, side, society, symbol, technology, test, trial and error, version, vertical

Outcomes

Science K–10 (inc. Science and Technology K–6)

- ST1-4WS investigates questions and predictions by collecting and recording data, sharing and reflecting on their experiences and comparing what they and others know
- ST1-5WT uses a structured design process, everyday tools, materials, equipment and techniques to produce solutions that respond to identified needs and wants
- ST1-15I describes a range of familiar information sources and technologies and how their purposes influence their design

Mathematics K–10

- MA1-1WM describes mathematical situations and methods using everyday and some mathematical language, actions, materials, diagrams and symbols
- MA1-2WM uses objects, diagrams and technology to explore mathematical problems
- MA1-8NA creates, represents and continues a variety of patterns with numbers and objects
- MA1-17SP gathers and organises data, displays data in lists, tables and picture graphs, and interprets the results

English K–10

- ENe-1A communicates with peers and known adults in informal and guided activities, demonstrating emerging skills of group interaction
- ENe-10C thinks imaginatively and creatively about familiar topics, simple ideas and the basic features of texts when responding to and composing texts

Syllabus Content

English

Speaking and listening 1

Students:

- respond to and compose texts
- engage in conversations and discussions, using active listening behaviours, showing interest, and contributing ideas, information and questions (ACELY1656)
- use a comment or a question to expand on an idea in a discussion
- use some persuasive language to express a point of view
- contribute appropriately to class discussions

Teaching, learning and assessment

Lesson 1: A design process

Summary

Students read Engibear's Dream as a stimulus to discuss the design process and the role of engineers.

Resources

- *Engibear's Dream* by Andrew King and Benjamin Johnston (also available through iTunes)

See, Think, Wonder

- Show students the cover of the book and have them discuss in pairs what they:
  - See: What can you see on the cover? For example, the title, robot, grid, construction site
  - Think: What do you know about engineers? What do you know about robots? Why do you think his feet were left blank?

Student diversity

- Wonder: What do you think the book might be about? What would you like to know about engineering?

- Discuss as a class.

Engibear's Dream

Read the text and during reading, discuss:

- the use of illustrations
- the purpose of the book
- what the book is trying to teach us. How do we know?

Think, pair, share

- Explain to the students that the book teaches us about a design process. Designers and engineers use this process to create the buildings and products we use every day.
- Students think, pair, share and discuss:
  - Is the first attempt always the best? Why/Why not?
  - What actions we can take to improve? For example, experimenting, trying new things, adding, modifying.
- Students study the pictures of the Bearbot drawings 1 to 10
  - students identify the features that are changed (modified) or added to each version of the Bearbots
  - students discuss the reasons for each modification
- Students report back to the class at the end of the activity by briefly summarising the key points from their think, pair, share activity:
  - What was similar in our discussions?
  - What is the process engineers use to design and build an idea?

Whole-class evaluation

- Discuss how engineers and scientists use the design process. To invent engineers and scientists experiment, test, modify and retest.
- Explain to students that in this unit they are going to:
  - solve some design problems
  - make modifications, change some ideas and maybe make mistakes

Syllabus Content

Science and Technology

Working Technologically

Students explore and define a task by:

- identifying needs and wants of users/audiences, eg using interview, observations and surveys.

Students generate and develop ideas by:

- using techniques for documenting and communicating design ideas, including simple plans, drawings and models, using familiar materials

Information

There is a range of information sources and technologies.

Students:

- interact with an information source or technology to explore the ways that different forms of information are combined, including text, image and sound, eg a website or digital game

The purposes of information sources and technologies influence their design.

Students:

- interact with a range of familiar information sources and technologies and identify their purposes, eg television programs, websites, digital games, newspapers and magazines
- describe how the purpose of a specific information source or technology influences its design, eg a website or game

Mathematics

Two-Dimensional Space 1

Students:

Teaching, learning and assessment

- use peer feedback to improve their ideas
- use a design process like engineers and scientists: experiment, test, modify and retest.

Lesson 2: What is a Scientist? What is an Engineer?

Summary

Students further discuss the role of engineers and scientists and how Engibear followed the design process to make a Bearbot. Students plan their own Bearbot on graph paper and include labels describing the features and functionality they would like in their Bearbot.

Resources

- Graph paper - http://www.printfreegraphpaper.com/

Whole-class discussion

Reflect back to the stimulus from last lesson and discuss:

- What does a scientist do?
- What does an engineer do?
- Was Engibear a scientist or an engineer? Why?
- What amazing things could Engibear's Bearbot do?
- Why do you think he made the Bearbot?
- What do you think was the purpose of the Bearbot?

Key inquiry questions

Pose the following questions:

- How could engineers and scientists work together? What sorts of things do they create to help us in our daily lives?
- What are some of the inventions we rely on in everyday life? For example, motor vehicles such as cars; household appliances such as the fridge and television; food items such as bread; and important lifesaving medicines and technologies.

Small-group discussion

- In what ways would our world be different if people didn't innovate and invent things?

Student diversity

Support

- Provide a list of key words to support the labelling

Extension

- Students use rulers and a compass to draw their design
- Highlight the term 'cross-section' (drawing 9) and create a shared definition. Students to create a cross-section drawing of their own design.

Syllabus Content

Recognise and classify familiar two-dimensional shapes using obvious features (ACMMG022)

- identify vertical and horizontal lines in pictures and the environment and use the terms 'vertical' and 'horizontal' to describe such lines

Teaching, learning and assessment

- How important are scientists and engineers in keeping us safe/healthy? Why?
- Is it important that scientists and engineers provide us with things to help us and entertain us? Why?

Whole-class discussion

- Discuss how scientists and engineers design/invent/build something new.

Individual or pair activity

- Ask students to think about making a Bearbot. What could their Bearbot do if they could create any design they wanted?
- Remind students to think about the way Engibear drew his Bearbot on the last page of the book. If possible, provide an enlargement for students to reference.
- Draw attention to:
  - the graph paper used. Show a sample of the paper they will use from the Engibear website and discuss the layout and features. How will the graph paper help us with our drawings? Which lines are 'vertical'? Which lines are 'horizontal'?
  - the labelling of the Bearbot features. Why is this important?

Individual activity

- Students draw their own Bearbot using graph paper and label key features.
- Ask students to consider:
  - What problems/needs will the Bearbot be able to address?
  - What will your Bearbot solution look like?
  - What will your Bearbot need to be able to do? Why will it need to do those things?
  - What specifications/descriptions are needed on your design?
  - How could the Bearbot be controlled by a computer?

Student diversity

Science and Technology

Working Technologically

Students evaluate by:

- explaining the strengths and limitations of what they did and what could have been done differently to improve the solution

Lesson 3: Designing a Bearbot

Summary

Students provide feedback to each other on their plans and are given the opportunity to improve their designs based on the feedback.

Syllabus Content

- identifying how their solution meets the needs and wants of users/audiences

Teaching, learning and assessment

Resources

- YouTube video: *Austin's Butterfly* (6 min 18 s)

Peer Feedback

- View *Austin's Butterfly*. The video shows children providing feedback to improve work.
- Students share their Bearbot designs with the class or in small groups.
- They should be encouraged to share:
  - the key features of their Bearbot
  - their ideas and how they changed
  - what worked well and what didn't work well
- Students provide feedback to their peers to help them improve their ideas
- Students are given the opportunity to apply the feedback and either improve their existing ideas, or do a new design.

Student self-assessment

Students reflect on:

- what they have learnt about the design process
- what it is like to be a scientist and/or engineer
- what they learned from receiving feedback from others.

Student diversity

Science and Technology

Working Scientifically

Students:

- question and predict by responding to and posing questions (ACSIS024, ACSIS037)

Information

There is a range of information sources and technologies.

Students:

Lesson 4: Computer coding

Summary

Students think about patterns in computer coding and experiment with Scratch Jr to develop their understanding about coding. In the process, students learn to solve problems, design products, and express themselves creatively using digital technology.

Resources

- Computers/tablets
- Scratch Jr app (available for iPad, Android and Chrome) - https://www.scratchjr.org/

Support

- Students can be given pre-coded file and asked to modify it (eg make the character move 5 steps instead of 3)
- Have the interface guide and block descriptions printed out for student reference

Extension

Syllabus Content

- interact with an information source or technology to explore the ways that different forms of information are combined, including text, image and sound, eg a website or digital game

The purposes of information sources and technologies influence their design.

Students:

- interact with a range of familiar information sources and technologies and identify their purposes, eg television programs, websites, digital games, newspapers and magazines
- describe how the purpose of a specific information source or technology influences its design, eg a website or game

Teaching, learning and assessment

- Scratch Jr guides and descriptions - https://www.scratchjr.org/learn.html
- Optional: *Hello Ruby* by Linda Liukas

Whole-class discussion

- Review what they learnt from *Engibear's Dream*:
  - What parts did you see inside Engibear's Bearbot?
  - How do you think Engibear could make his Bearbot perform all those actions?
- Discuss how small, built-in computers 'tell' the objects what to do:
  - a washing machine has a computer inside it to tell it how to wash the clothes
  - a microwave has a computer inside to tell it how to cook the food
  - toys that talk or move have small computers inside them to organise the sounds and move the appropriate parts.
- Brainstorm other objects that use computers to help them move/talk/perform.

Whole-class explanation

- Explain:
  - All of these small computers inside these objects have instructions written in codes that tell the computers what to do.
  - Code can be written using words or by linking blocks on a computer
  - Scratch is software that allows us to create code using blocks
  - Students will be investigating how basic coding is achieved by planning algorithms (a list of instructions) to move a character and coding the algorithms in Scratch.
- Demonstrate:
  - Select a student to be your character and to follow your algorithm
  - Tell the student to perform particular actions that are written on the board (eg move forward 3 steps, spin, turn)
  - Show how the character in Scratch Jr can be coded to do similar actions using linked blocks

Small-group activity

- Students explore the different features of Scratch Jr.

Student diversity

Students with previous experience with Scratch Jr can explore the full Scratch environment:

- https://scratch.mit.edu/
- Intro video - http://splash.abc.net.au/home#!/topic/2117719/coding
- Video tutorials - scratch.mit.edu/help/videos/
- Cards - scratch.mit.edu/help/cards/

Syllabus Content

Teaching, learning and assessment

- Do a PMI (plus, minus and interesting) reflection to discover the positive (plus), negative (minus) and interesting (I) aspects of using Scratch Jr. PMI reflection encourages students to look at other points of view. The 'interesting' column contains ideas that may require further research or discussion.
- Come back as a class and create a class brainstorm of the PMI reflection

Class evaluation

- What were the information sources you saw being combined in the software? For example, text, image, sound. How was this helpful when making your code?
- What else could you use Scratch Jr to do? For example, students can program their own interactive stories and games.
- What do you think is the purpose of a program like Scratch Jr? Who might use it and how?

Optional: Read *Hello Ruby* by Linda Liukas and do some of the paper-based coding activities as extra stimulus to introducing coding.

Student diversity

Mathematics

Patterns and Algebra 1

Students:

Investigate and describe number patterns formed by skip counting and patterns with objects (ACMNA018)

- identify and describe patterns when skip counting forwards or backwards by ones, twos, fives and tens from any starting point
- recognise, copy and continue given number patterns that increase or decrease, eg
  1, 2, 3, 4, ...
  20, 18, 16, 14, ...
- create, record and describe number patterns that increase or decrease
- recognise, copy and continue patterns with objects or symbols
- create, record and describe patterns with objects or symbols

Lesson 5: Coding patterns

Summary

Students develop their current understanding about patterns and how they relate to algorithms. Students create an algorithm that is made up of a repeated pattern and use Scratch Jr to code it.

Resources

- Computers/tablets with Scratch Jr
- *Can I make my characters dance?* Tutorial - https://www.scratchjr.org/activities/card02-dance.pdf

Whole-class discussion

- Recap the key understandings about Scratch Jr from the previous lesson.

Whole-class activity

- Students define different actions (eg clap, stomp, sing) using different shapes (eg triangle, circle, exclamation mark)

Support

- Students follow the *Can I make my characters dance?* tutorial
- Have the interface guide and block descriptions printed out for student reference

Extension

- Students choreograph and code a dance involving more than one character

Syllabus Content	Teaching, learning and assessment	Student diversity
Describe a repeating pattern of objects or symbols in terms of a 'number' pattern 🎓	▪ Teacher draws a simple repeated pattern using the shapes on the board and the students perform the actions as a class. What will come next in this pattern? How do you know? ▪ Students draw at least three shapes in an order and repeat the order a number of times to form pattern. ▪ Students share their pattern with a partner and have the partner perform the actions: - Did your partner perform the right pattern? If not, why? ▪ Teacher defines the term algorithm and pattern: - A pattern is a set of numbers, symbols or actions that are arranged following a rule - An algorithm is a set of instructions arranged in an order or sequence. Algorithms can include patterns. **Small-group activity** – Design a dance pattern ▪ Explain to students that they will be making their own pattern and algorithm through dance. ▪ Pose questions to lead joint development of a design criteria: - What criteria can we define to assess our own and others' learning about patterns and code? - What criteria will help us create a quality dance sequence and provide feedback to our peers? ▪ Define symbols and actions, For example, ! = arms up, ^ = jump and clap, < = slide left ▪ Create and draw a pattern to dance to. For example, !!!^^^<<<!!^^<<!!!^^^<<< - What would come next in my dance pattern? How do you know? ▪ Students work in small groups to create their own dance pattern using 3–5 symbols. **Small-group activity** – Code a dance pattern ▪ Prior to coding, as a class discuss: - What could you do if your computer character can't do exactly the same dance move you did in the dance pattern? Even though your computer character can’t do the exact dance moves you did in your dance pattern, you can still choose a different movement for your symbol but keep the same pattern. - How will we know when we have a repeated pattern? - How will we recognise if there is an error in our pattern? ▪ Students code the dance pattern in Scratch Jr. Students may follow the *Can I make my characters dance?* tutorial if they need extra guidance	

Syllabus Content

Science and Technology

Working Scientifically

Students question and predict by:

- making predictions about familiar objects and events and the outcomes of investigations (ACSIS024, ACSIS037, ACSHE021, ACSHE034)

Students plan investigations by:

- identifying the purpose of the investigation

Students conduct investigations by:

- using informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate (ACSIS026, ACSIS039)
- making and recording observations and measurements honestly, using tally marks and informal units

Students process and analyse data and information by:

- describing changes in objects and events observed in investigations (ACSHE021, ACSHE034)

Teaching, learning and assessment

- Share your dance patterns and Scratch code with a friend.

Whole-class activity

- Students present their pattern to the class, and:
  - describe their pattern as a number pattern
  - explain how it works (why it is a repeated pattern)
  - teach it to the class, using their Scratch Jr code as an 'instructional video'.

Self-evaluation and assessment

- Students may wish to have their presentation recorded to enable them to reflect on their learning and how well they understand repeating patterns.

Lesson 6: Dancing bots

Summary

Students plan and code a dance sequence for a robot. Students can use physical robots, like Bee-Bots, or can design a robot character and create the dance in a computer-based environment.

Resources

- Bee-Bots
- YouTube video: RoboCup Junior Australia 2013 Senior Dance National Championships - Finals Performance (2 min 23 s)

Hook:

View a video of a Robocup dance competition (see Resources) and discuss:

- What dance moves did the robot perform?
- Did you see any patterns in his dance?
- What technology was built into the bot to allow it to dance?
- How do you think the robot was coded to perform the dance?

Robot investigation

Student diversity

Extension

- Students use formal measuring tools when investigating the movement of the robot

Syllabus Content

- comparing observations with predictions through discussion, as to whether observations were expected and related to their questions and/or predictions (ACSIS212, ACSIS214)

Working Technologically

Students explore and define a task by:

- identifying needs and wants of users/audiences, eg using interview, observations and surveys

Students generate and develop ideas by:

- exploring different materials by observing and manipulating them and using trial-and-error
- using techniques for documenting and communicating design ideas, including simple plans, drawings and models, using familiar materials

Students produce solutions by:

- suggesting simple steps for production
- using a range of everyday tools, equipment, materials and techniques
- working cooperatively and safely

Students evaluate by:

- explaining the strengths and limitations of what they did and what could have been done differently to improve the solution
- identifying how their solution meets the needs and wants of users/audiences

Information

There is a range of information sources and technologies.

Students:

- interact with an information source or technology to explore the ways that different forms of information are combined, including text, image and sound, eg a website or digital game

Teaching, learning and assessment

- Teacher demonstrates how the robot moves and is coded
- Students design a small investigation to observe how the robot moves within its environment. For example:
  - How far the robot moves with one press of the directional button
  - How long the robot takes to move in the shape of a square
  - Does the robot move further/faster on carpet or tiles/vinyl
- Students make a prediction about what they expect the results will show based on the observations of the teacher's demonstrations
- Students conduct the investigation, ensuring they take at least three measurements using informal measuring tools, such as paperclip lengths (distance), or counting out loud (time)
- Students discuss their results in a small-group:
  - Were the results what they expected? If not, why do you think this is the case?
  - Why did we test the robot a number of times?
  - How will the results help you to code the robot to dance?

Small-group activity

Students

- work in their teams
- decide on the moves their robot can perform
- design a new dance sequence algorithm on paper that includes a repeating pattern
- code their robot to perform the dance
- test and modify the code as needed
- code extra robots to perform the same dance moves in unison by sharing their code with another group to put on their robot (or copying the code onto another character)
- have their robot(s) 'perform' the dance to the rest of the class.

Team evaluation

- How was the robot limited in the dance moves it could do?
- Why was it important to test your code before the performance?
- Did your robot perform as well as you expected? Why/why not?

Student diversity

Syllabus Content

Science and Technology

Working Technologically

Students explore and define a task by:

- Identifying needs and wants of users/audiences, eg using interview, observations and surveys.

Students generate and develop ideas by:

- Exploring different materials by observing and manipulating them and using trial-and-error

Students produce solutions by:

- suggesting simple steps for production
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- working cooperatively and safely

Students evaluate by:

- explaining the strengths and limitations of what they did and what could have been done differently to improve the solution
- identifying how their solution meets the needs and wants of users/audiences

Information

The purposes of information sources and technologies influence their design.

- Interact with a range of familiar information sources and technologies and identify their purposes, eg television programs, websites, digital games, newspapers and magazines

Teaching, learning and assessment

- Did both/all robots perform the dance exactly the same (ie were they in unison)? Why/ why not?
- How did you take turns or share the coding responsibility?

Lesson 7: What else can we code?

Summary

The focus of this activity is for students to investigate other forms of digital technology that rely on coding.

Example digital technology to investigate

- Hardware:
  - Bee-Bots
  - Ozobots
- Software (Apps):
  - Daisy the Dinosaur by Hopscotch Technologies
  - Move The Turtle - http://movetheturtle.com/
  - Cargo-Bot by Two Lives Left - http://twolivesleft.com/CargoBot/

Whole-class activity

- Introduce students to the selected digital technology (eg Bee-bots)
- Discuss the similarities and differences between the technology and Scratch Jr and/or Bee-Bots
- Brainstorm other uses of robots. Show videos of robots performing a range of tasks.
- Outline challenge:
  - To code the technology to perform a task or activity
  - You should be able to explain why it is important the robot does this task/activity. For example, it's safer for robots to do it; robots can do it more precisely (neatly); robots are stronger and/or won't get tired.

Small-group activity

Students:

- work in their teams to explore the new technology and experiment with coding different actions
- decide on a goal for their robot, for example:

Student diversity

Extension

- Students use the app *Explain Everything* to present what they have learnt about the selected technology.
- Students design and build the environment for their robot out of recycled materials or in a paint application

Syllabus Content	Teaching, learning and assessment	Student diversity
	- move through a maze to rescue a lost child (Bee-Bots) - draw a flower pattern (Turtle) - move objects on a 'construction site' (Ozobot) ▪ Code the technology to perform/demonstrate the task ▪ Test and refine the code ▪ Present the robot completing the task to the rest of the class **Group evaluation** ▪ What knowledge is required to code using the selected technology? ▪ How was coding the 'robot' to perform the task similar to coding a dance sequence? How was it different? ▪ Why is it important to test your code? ▪ Did your robot perform as well as you expected? Why/why not? ▪ What would you like to code next?	

Assessment overview

Students produce a variety of work samples as they participate in STEM investigation, and design and development activities. These should be evaluated to determine students' level of achievement and understanding. Student understanding may also be assessed through the analysis of contributions to class discussions, team work and demonstrations of thinking skills, recorded using observational checklists or anecdotal records. Refer to the unit overview document for assessment for learning ideas for each outcome.

Evaluation

Questions to guide reflection:

- To what level did students achieve the learning outcomes?
- How effective were the activities in helping students to understand key concepts and achieve the learning outcomes?
- How did the teaching strategies and activities facilitate student engagement?
- How could the unit be improved to enhance student engagement and learning?