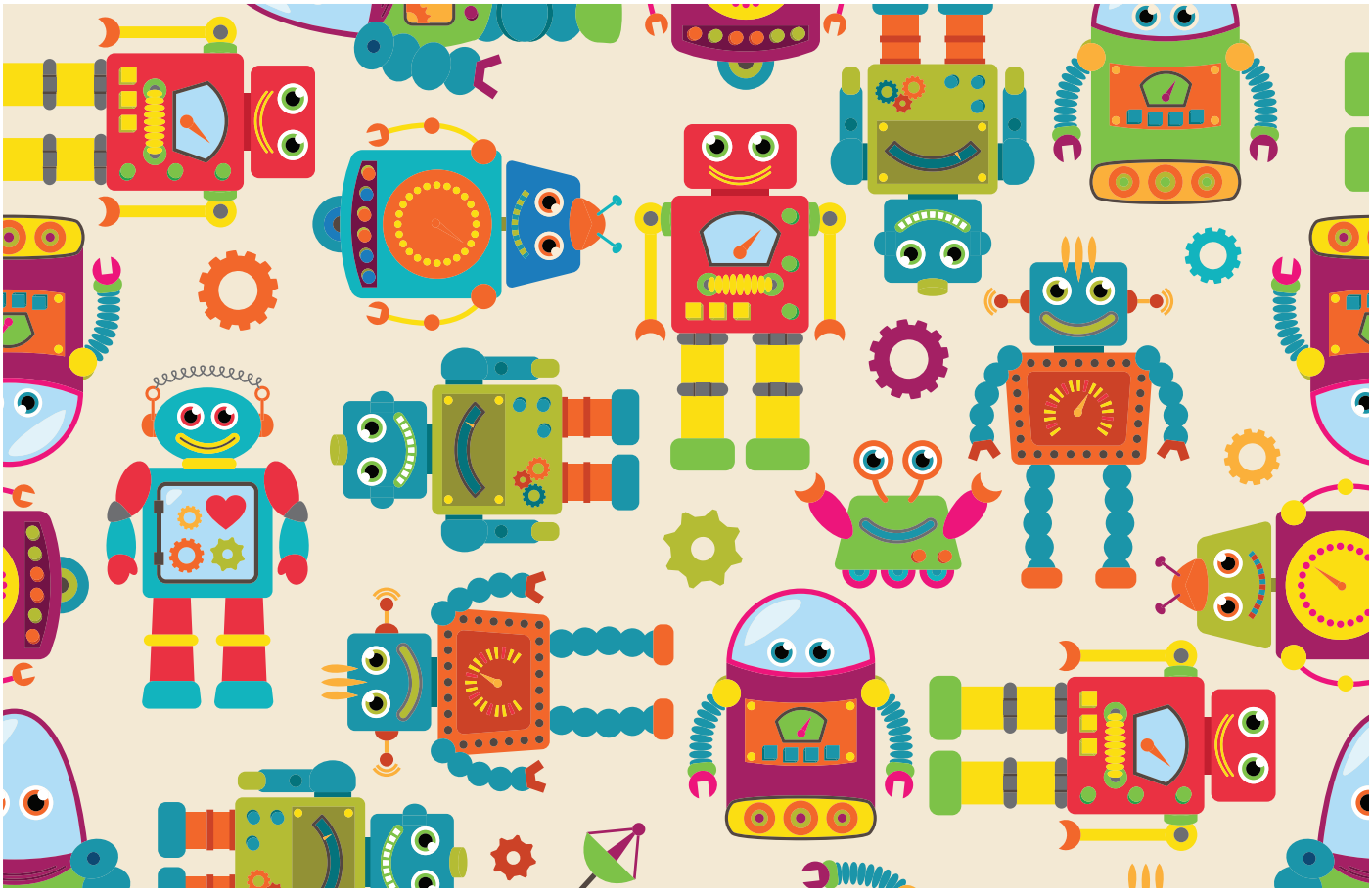
THE MATHEMATICAL ASSOCIATION OF VICTORIA

Algorithmic thinking resources

Year 5: Robot arms



In this lesson students follow the systematic steps of coding to create structures and patterns using cups.

Level 5 - Number and Algebra | Pattern and algebra | Follow a mathematical algorithm involving branching and repetition (iteration). (VCMNA194)

MATHEMATICAL LANGUAGE

Algorithm - A series of instructions to complete a task
Coding - Transforming actions into a symbolic language
Debugging - Finding and fixing issues in codes
Function - A piece of code that can be used over and over, such as repeats

MATERIALS

- Cups (approx. 6 per student)
- Student resource The Cup Song www.dltk-kids.com/crafts/music/mcupsong.htm
- Student tutorial The Cups Song www.dltk-kids.com/crafts/music/mcupsong.htm

WARM UP - THE CUP SONG

- Print out the tutorial of The Cup Song and watch the online tutorial.
- Practise the steps of the song with the students.
- Discuss the steps focusing on those steps that are repeated.
- Ask the students 'Could the steps be more efficient?'
- Run through the song together as a group

LAUNCH

- This activity teaches students the connection between symbols and actions, as well as the valuable skill of debugging.
- Ask the class if anyone has heard of robotics. Has anyone seen a robot or touched one? Does a robot

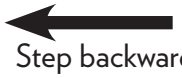
really 'hear' you speak? Does it really 'understand' what you say? The answer to the latter question is: 'Not in the same way as a person does.'

- Robots operate using instructions: specific sets of things that they have been pre-programmed to do. To accomplish a task, a robot needs to have a series of instructions (sometimes called an algorithm) that it can follow. This activity teaches the students what it takes to make that happen.

EXPLORE

- Using these instructions:

Step forward

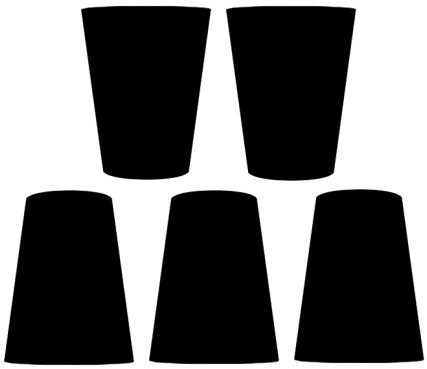


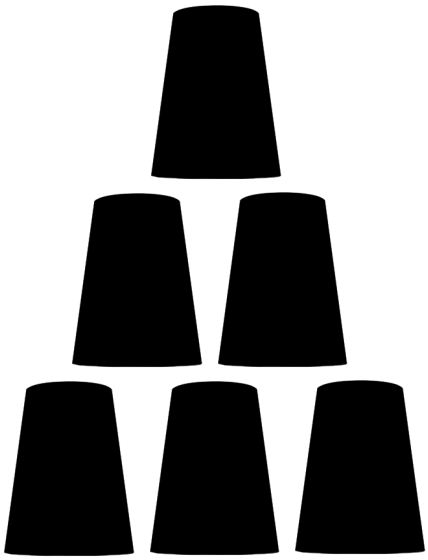
Step backward

Turn cup left 90 degrees

Turn cup right 90 degrees

Program a robot to build these towers





- What instructions need to be established for this to be possible. Note no words are allowed, only the simple written instructions or symbols provided to replicate movement of a robotic arm. Are arrows sufficient, and is the task possible?
- Students explore the problem, and change, refine, 'debug' the program so that the stack can be built.
- Students should have a program written down that the robot arm needs to follow to create the stack. If the stack the robot arm creates matches the picture, it is a correct program. However, the question remains: is there a more efficient way?

SUMMARISE

Evaluation and summary is the process by which we examine algorithms to determine their usefulness, adaptability, efficiency and correctness.

There may be many algorithmic solutions to a problem; the Evaluation and summary process asks which one was best and why?

Students share their findings, with students reading out their programs, and other students 'robotic arms' following along.

- Did everyone end up with the same structure?
- What debugging needs to done to fix the program?
- Is there a more efficient way to complete the program?

Important – Emphasise that every 'programmer' will make mistakes, so debugging is a normal part of the process.

ENABLING PROMPTS

- Use of a simpler structure involving 3 cups
- Provide a set of instructions, with students following along to see what structure it creates, rather than students creating the program. This way students are able to follow along to understand the process and instructions that leads to a successful completion of the task.
- Provide a series of cards with arrows and symbols that students may use.

EXTENDING PROMPTS

- Have students create more difficult structures that require more complex programs. How do they know they have completed the program in the most efficient way?
  The focus here is not just to get one answer, but to get the best answer.
- Attempt to program some more complex structures. See below for some ideas.

QUESTIONS TO ENCOURAGE DEEPER THINKING

Students may have found a successful program to complete the task, but can it be done more efficiently, perhaps in less steps? This is where the concepts of loops and other functions can vastly improve a program. Challenge students to use a loop or repeat function, rather than a repeated step, to make their program more eloquent and efficient.

EXTENDED VICTORIAN CURRICULUM LINKS MATHEMATICS

Level 4 - Number and Algebra

Pattern and algebra

- Define a simple class of problems and solve them using an effective algorithm that involves a short sequence of steps and decisions (VCMNA164)

Level 5 - Number and Algebra

Pattern and algebra

- Follow a mathematical algorithm involving branching and repetition (iteration). (VCMNA194)

Digital Technologies

Data and information

- Plan, create and communicate ideas, information and online collaborative projects, applying agreed ethical, social and technical protocols (VCDTDI029)

Creating Digital Solutions

- Define problems in terms of data and functional requirements, drawing on previously solved problems to identify similarities (VCDTCD030)
- Design a user interface for a digital system, generating and considering alternative design ideas (VCDTCD031)
- Design, modify and follow simple algorithms represented diagrammatically and in English, involving sequences of steps, branching, and iteration (VCDTCD032)
- Explain how student-developed solutions and existing information systems meet current and future community and sustainability needs (VCDTCD034)