# Programs, Packages and Apps:

# *Principles for technology integration in Primary and Early Childhood Mathematics*


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MAVMGSE Primary and Early Childhood Conference

Friday 21st of June 2019


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# Twitter – Make Use of it!

- Yesterday you were invited to make use the Twitter #MAGMEV2019.
- I encourage you to do this but also cultivate a range of people to follow for the purpose of Professional Learning
- Prof Darling Hammond just happened to tweet yesterday and it was a perfect way of introducing this talk…

**LindaDarling-Hammond** @LDH_ed · 1d

The fear of new technologies is as old as Socrates -- who railed against books. It continues in heated debates about the role of tech in the classroom. Our debates should get past *if* we need them and address how to use them well. See my blog in @Forbes

Technology in the Classroom: The Question Is Not Now "If" but "How"

forbes.com

# Overview

This presentation is based on a paper printed this year in APMC (Symons & Pierce, 2019).

In the paper 5 principles for technology integration in primary and early childhood mathematics are presented.

Initially a broad context/introduction will be provided and then the presentation will be structured according to the 5 principles:

- Access the affordances of Web 2.0
- Ensure an equitable approach to technology integration
- Invest in professional learning, not just techno-gadgets
- Offset procedural fluency with deeper conceptually driven learning
- Use interactive devices interactively


# Introduction/ Context

- I started thinking about the issue of Technology in Primary Mathematics quite some time ago.
- I often observed mathematics teaching occurring in rotations that might include:
  - Explicit Teacher Group
  - Worksheet Group 1
  - Worksheet Group 2
  - Dice Game Group
  - Computer Group
- Often this occurs under the name of 'differentiation'.
- My experience was that technology in Primary Mathematics in particular was approached in a very superficial way.
- Generally, technology/ computers (in my view) were being used at best to drill mathematical fluency and at worst as a 'babysitter'.

# Our Focus: The 'Computer Group'

Google

maths games

All | Videos | Images | Shopping | News | More | Settings | Tools

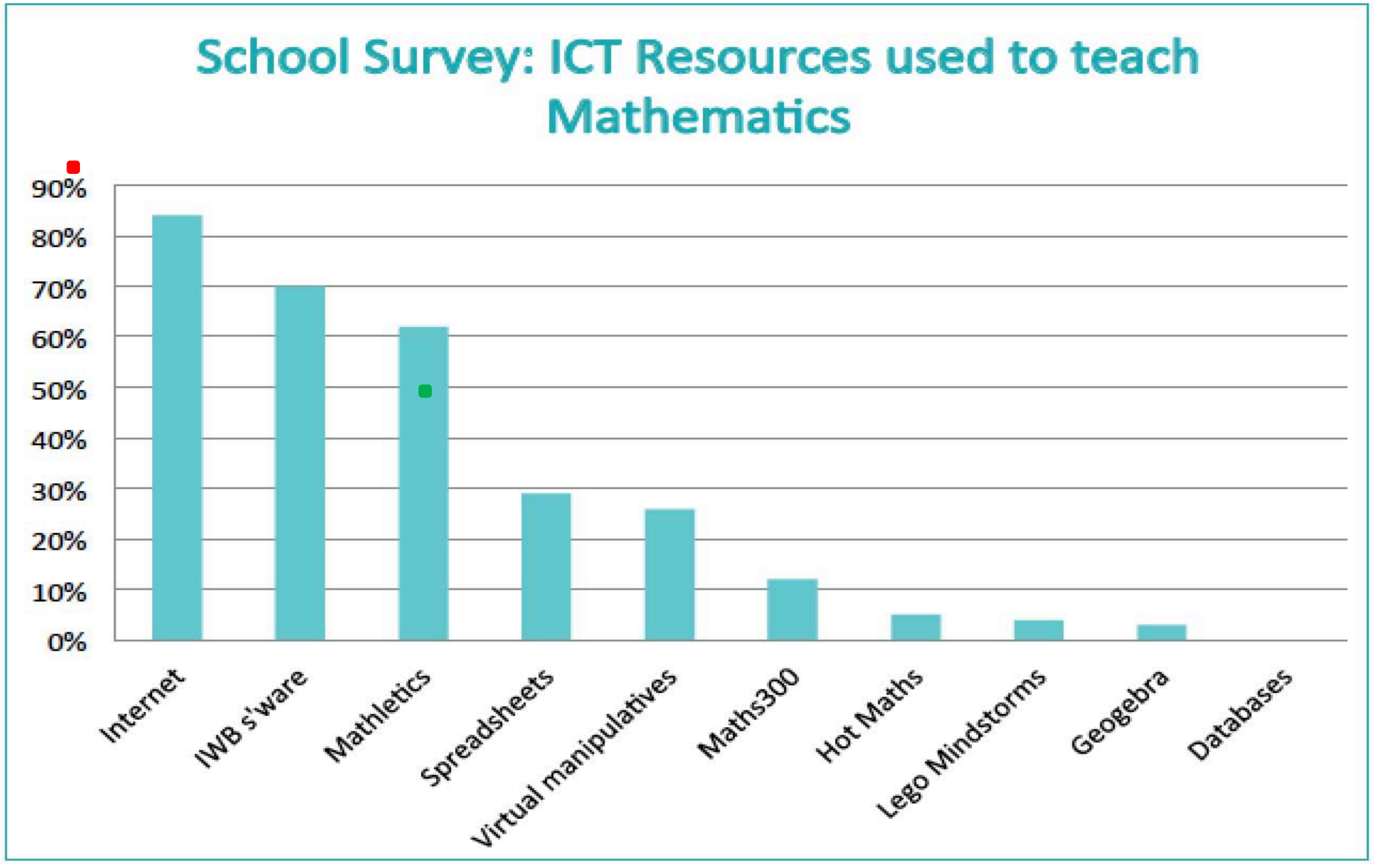
About 154,000,000 results (0.55 seconds)

**Most Popular Free Maths Games**

- × Tommy's Trek - Times Tables. ...
- **Maths** Road Hopper - Multiplication. ...
- Super **Maths** Bowling - Multiplication. ...
- Mini **Maths** Motors - Multiplication. ...
- Marlon's Magical **Maths** Mission - Multiplication. ...
- **Maths** Race - Multiplication. ...
- Archery Arithmetic - Multiplication. ...
- **Maths** Maze Monsters - Multiplication.

More items...

# The ‘Computer Group’




(Day, 2013)

# 2 Examples

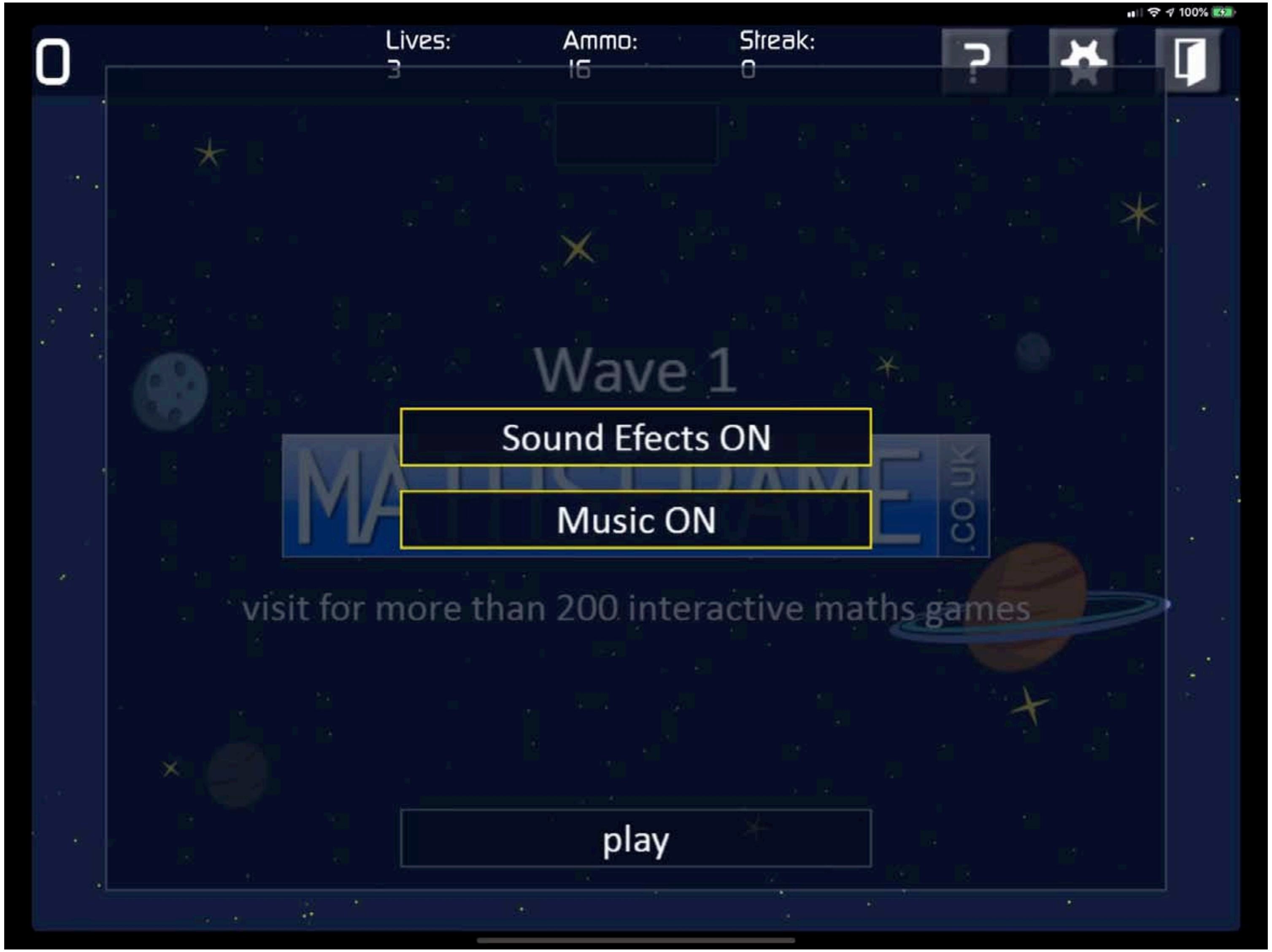
Tommy’s Trek

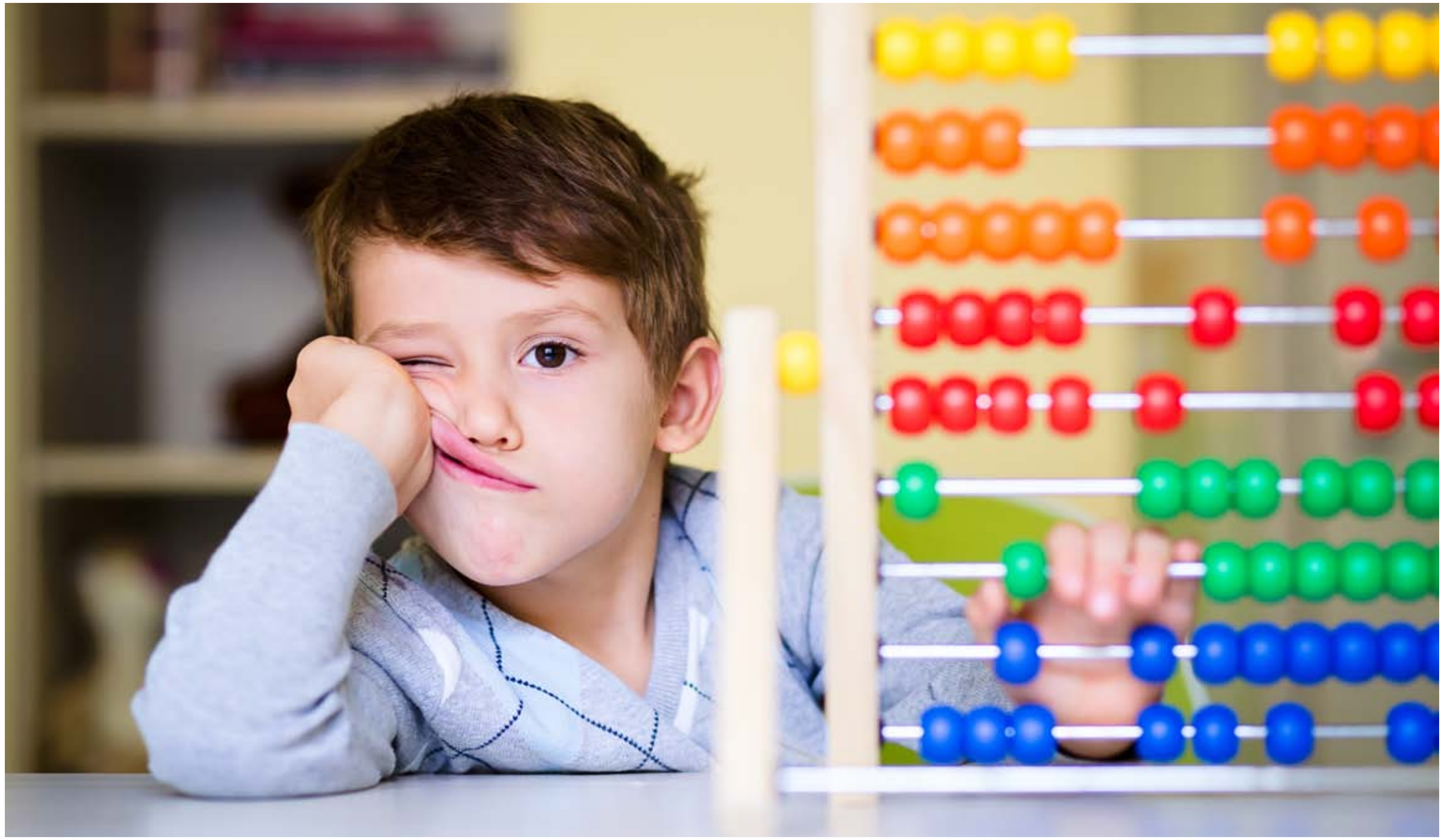
- Observe these two examples of me playing these maths games.
- Discuss…

# 2 Examples

<u>Maths Invaders</u>

- Observe these two examples of me playing these maths games.
- Discuss…



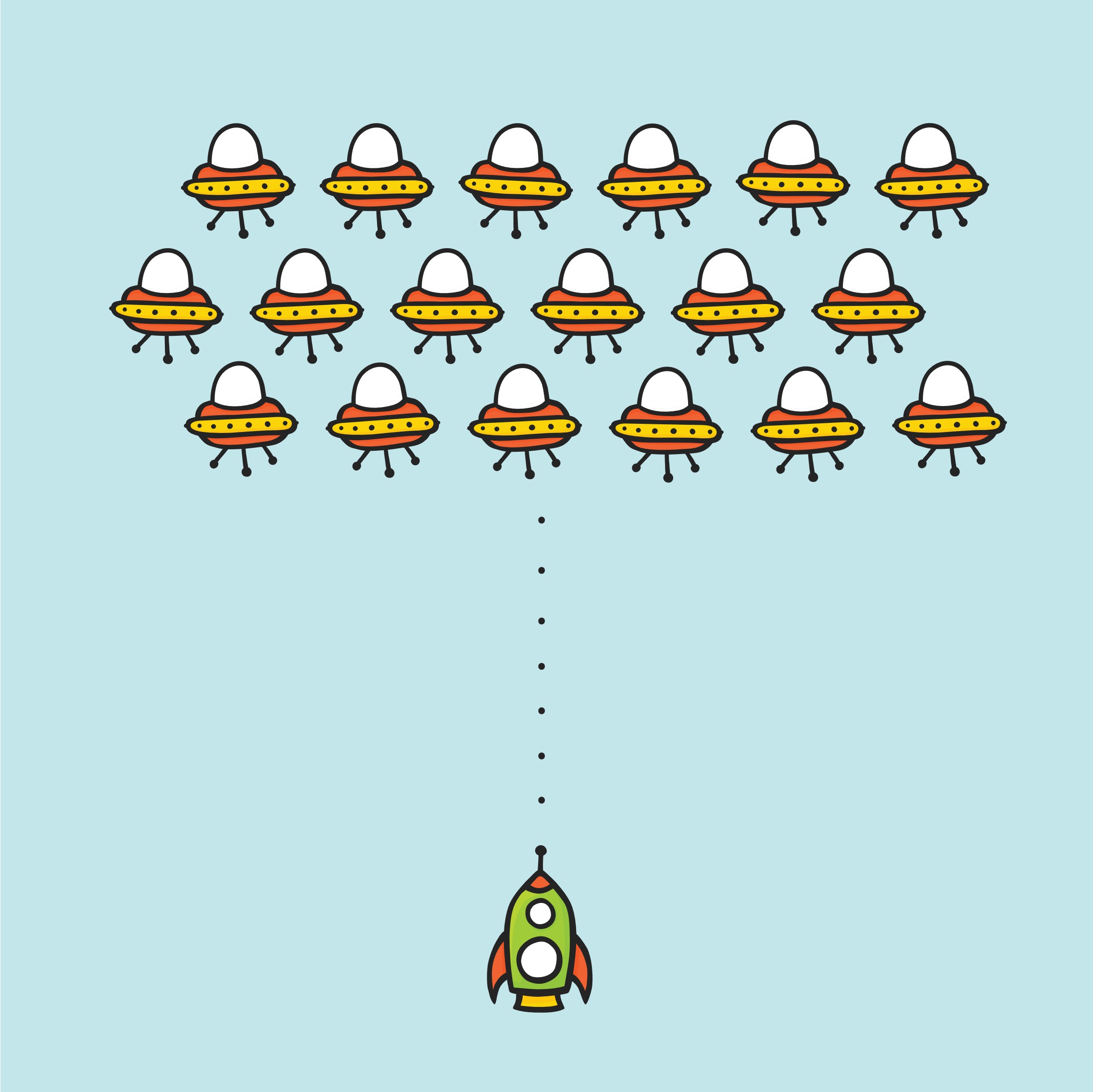


# Year 5 Students Comment about technology in mathematics:

*"We don't really use our- well we do but we haven't really used computers for maths because we go to math group – we signed on math groups and we only – we take our computers but sometimes, we don't really use it because we have the interactive white board and all that but last term, we had this Maths 300 and we were going to use it but we still haven't used it. So – yeah. "*

# Year 5 Students Comment about technology in mathematics:

*“The multiplication games are more of like games but they don’t really teach you anything because all you just do is just click, click, click. With the games – with the typing ones and not really anything because you’re just seven, enter.”*

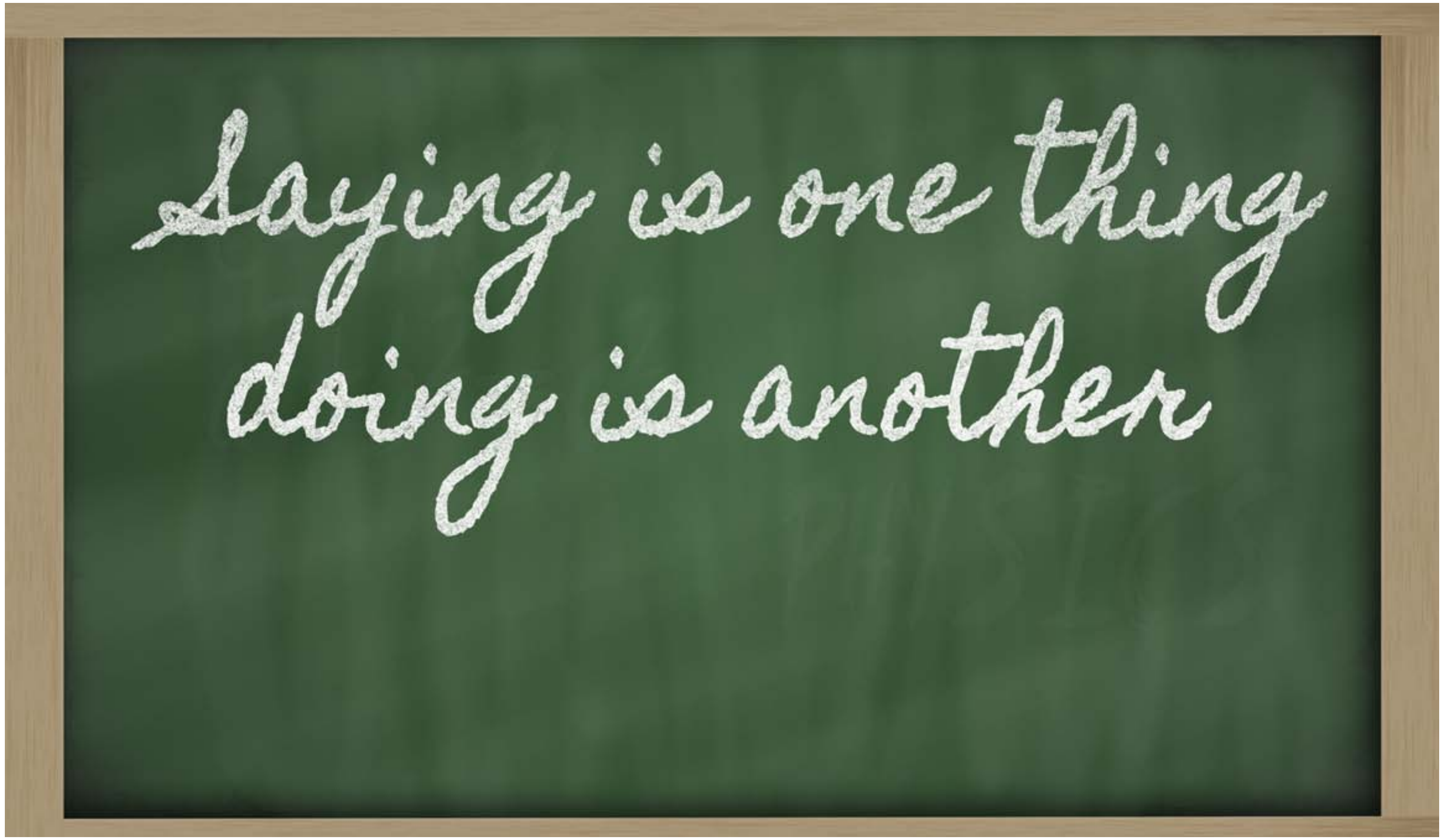


# Year 5 Students Comment about technology in mathematics:

*"I remember last year, kids were just going, "Yes! we got computers in our math groups!" 'Cause they thought it was really kind of a – Hour off – just like, secretly just doing really nothing."*

# Observations about Most Common Mathematics Games

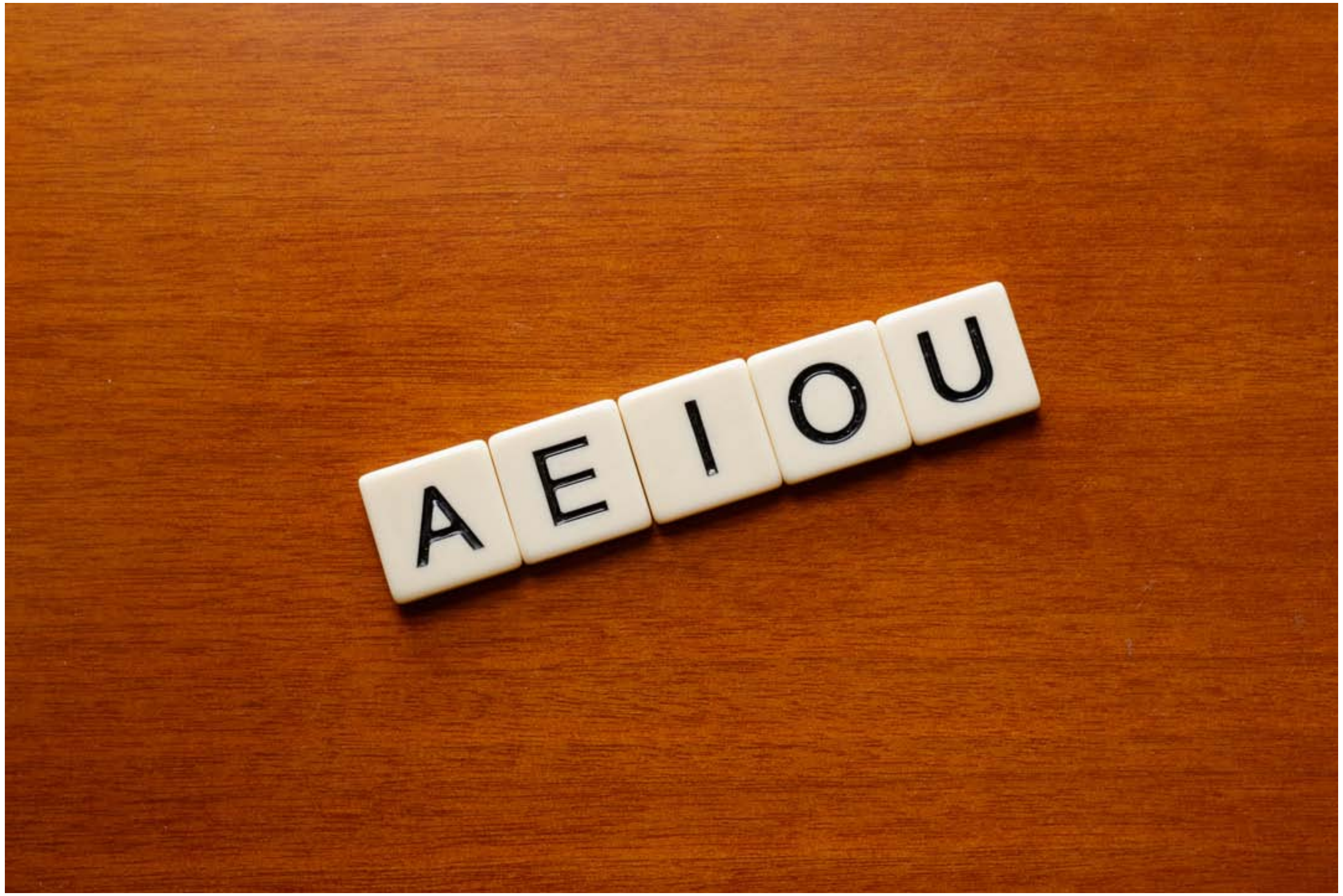
- They are often a lot of ‘fun’!
- Purely focused on procedural ‘fluency’ (if any mathematical focus at all)
- Mostly focused on Multiplication Facts
- No attempt to develop strategies
- No attempt to develop problem solving, understanding or reasoning
- Are often played (successfully) with no thought given to the ‘mathematics’
- Often include advertising
- Often integrated into large commercial ‘program’s to support ‘maths improvement’




This use of technology occurs despite the Australian Curriculum stating:

*Students develop ICT capability when they investigate, create and communicate mathematical ideas and concepts using fast, automated, interactive and multimodal technologies. They employ their ICT capability to perform calculations, draw graphs, collect, manage, analyse and interpret data; share and exchange information and ideas and investigate and model concepts and relationships. (ACARA, 2019)*

Please Note: The order of these principles isn't significant in any way other than it allowed us to begin them with each vowel in order ☺




# Access the affordances of Web 2.0

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# Using Online Collaborative Learning in Mathematical Problem Solving

- 54 grade 5 were placed in small groups within Edmodo and engaged in mathematical problem solving within the online space.
- The students were placed into small mixed ability groups of 3 – 5.
- I attended a school for nine weeks, introducing the problem and leading a discussion (ensuring that the students understood what was required)
- Students then solved the problems online (at home) asynchronously (not in real time) via the medium of a message board.
- Students were provided no classroom based support in the final two weeks.

There are lots of other Platforms you can choose from…

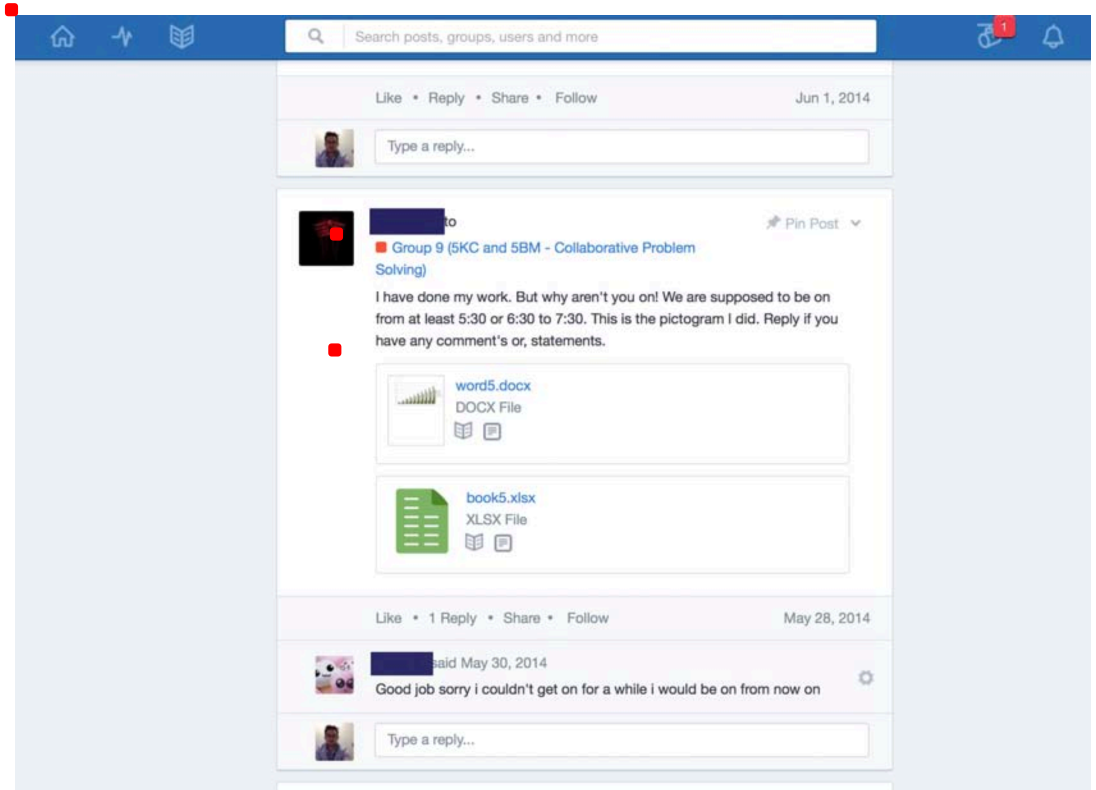
- Google Classroom
- Padlet
- Moodle
- Swad
- Explain Everything


# Whatever you choose…

Please be able to clearly justify your choices

# Choices for one Online Platforms

- Edmodo was chosen for because it:
  - Was intuitive;
  - Allowed for the creation of small groups within the larger group;
  - Allowed for student created files (artefacts) to be uploaded to support their thinking and
  - Was somewhat familiar, as students had worked with this online platform (to a limited extent) in the previous year.



# Example Problem

## The problem

It is sometimes said that each year a human lives is equivalent to 5 cat years. What does this mean? How old is your cat in human years (If you don't have one, pretend!)?

- Create a 'cat age' table in Excel. This should include columns for a cat's age and a column for the equivalent human age (up to 100 years).
- Create a line graph in Excel representing these data up to 100 human years.
- You may copy both the table and graphs that you have created into Word. In Word summarise what the graph shows. You may also include images.
- Every year a human lives is said to be the same as two years for a camel. Repeat the above process for camels (add to your chart). How old are you in camel years?
- Some lorikeets live to be 25 years old. Add a column to your table that makes it easy to convert between lorikeet and human ages.
- Use the table to tell how old the members of your family would be if they were lorikeets.
- Create a graphical representation using Excel displaying the various animal data up to 10 'human' years.

# Discussion

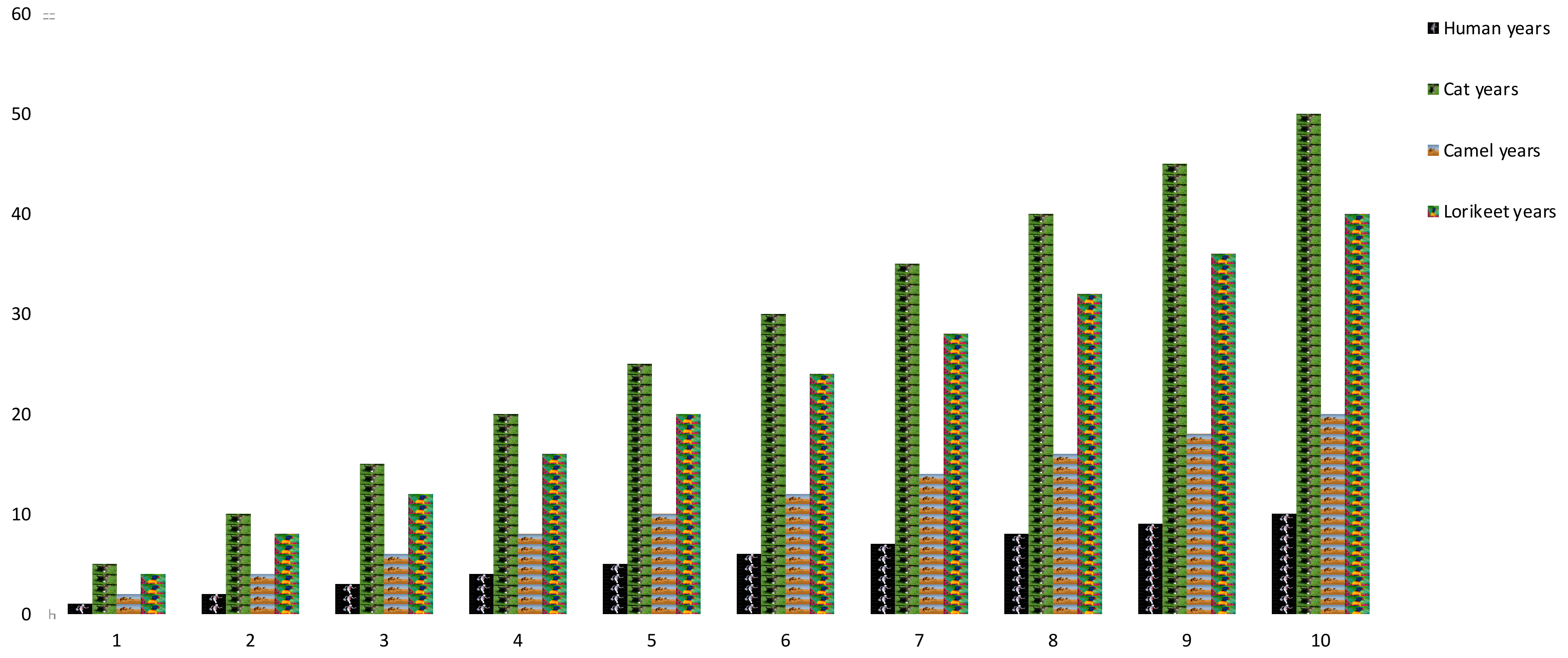
Understanding Problem

Creating Strategy/ clarifying

Solution?

Olivia: What does it mean by saying ***how old***? Could someone please help me?
Zander: It means ***what age*** is your cat.
Chris: We should also put more animals like elephants and giraffes.
Olivia: Yeah but first we need to do the cats and the other animals that Mr Symons has given us so we should be talking about that first and then do the other animals in a different Excel document. So how would we be doing the cat one first? Let's discuss the cat one first.
Olivia: I still kind of don't get it when it says by ***human years*** could anyone help me, please?
Zander: What do you mean. You just ***go up by one***. I'm confused.
Olivia: So, what we should do in my opinion is for the cat we could work it out with the strategies that Mr Symons showed us and like for the camel as well and then should we put all of them together?
Zander: I am ***20 years old in camel years.***
Olivia: Yea same.
Zander: I'm going to do the section where you have to show ***how old your family is*** if they were lorikeets.
Olivia: I'm not really sure about that section but soon I will be doing ***the cat years***, and ***for the cat years it goes by 5s yeah?***
Olivia: ***So, like 5, 10 , 15*** and so on. What does it need ***to go up to again?***

# Example Artefact



# Example Artefact

=B7*2

| B | C | D | E |
|---|---|---|---|
| | Animal ages | | |
| Human years | Cat years | Camel years | Lorikeet years |
| 1 | 5 | 2 | 4 |
| 2 | 10 | 4 | 8 |
| 3 | 15 | 6 | 12 |
| 4 | 20 | 8 | 16 |
| 5 | 25 | 10 | 20 |
| 6 | 30 | 12 | 24 |
| 7 | 35 | 14 | 28 |
| 8 | 40 | 16 | 32 |
| 9 | 45 | 18 | 36 |
| 10 | 50 | 20 | 40 |


# Ensure an Equitable Approach to Technology Integration

# Equity in Tech Integration

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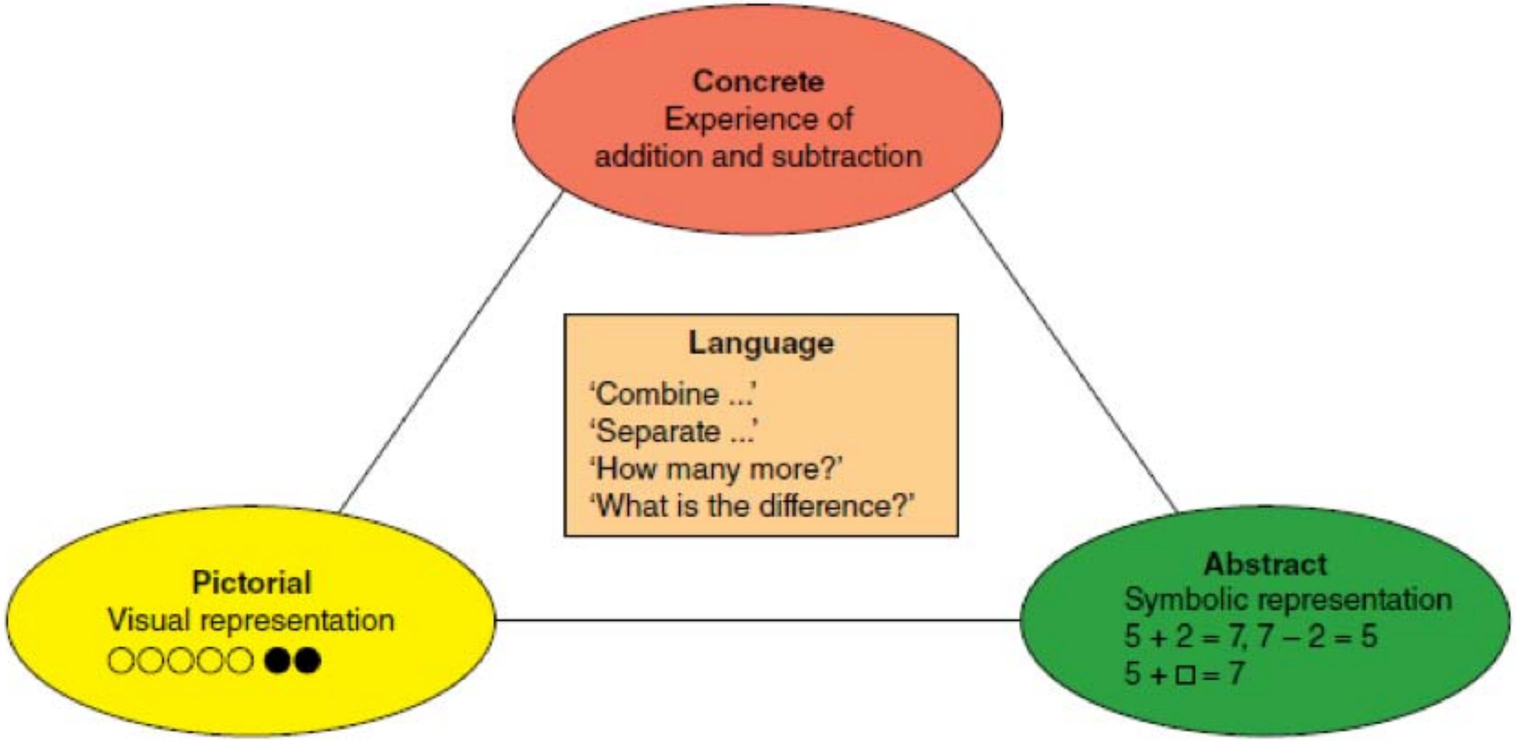
- Livingstone (2012) expressed the concern that :

*unless access to both computers and the Internet (if required) are universal, a proportion of students may be unfairly disadvantaged.*

- Student access to computers; iPads, tablets or other devices; and the Internet is unequal and therefore potentially discriminatory.
- School leaders need to be aware of the access that students have and, as necessary, supplement this by facilitating access to school computers or tablets before or after school.

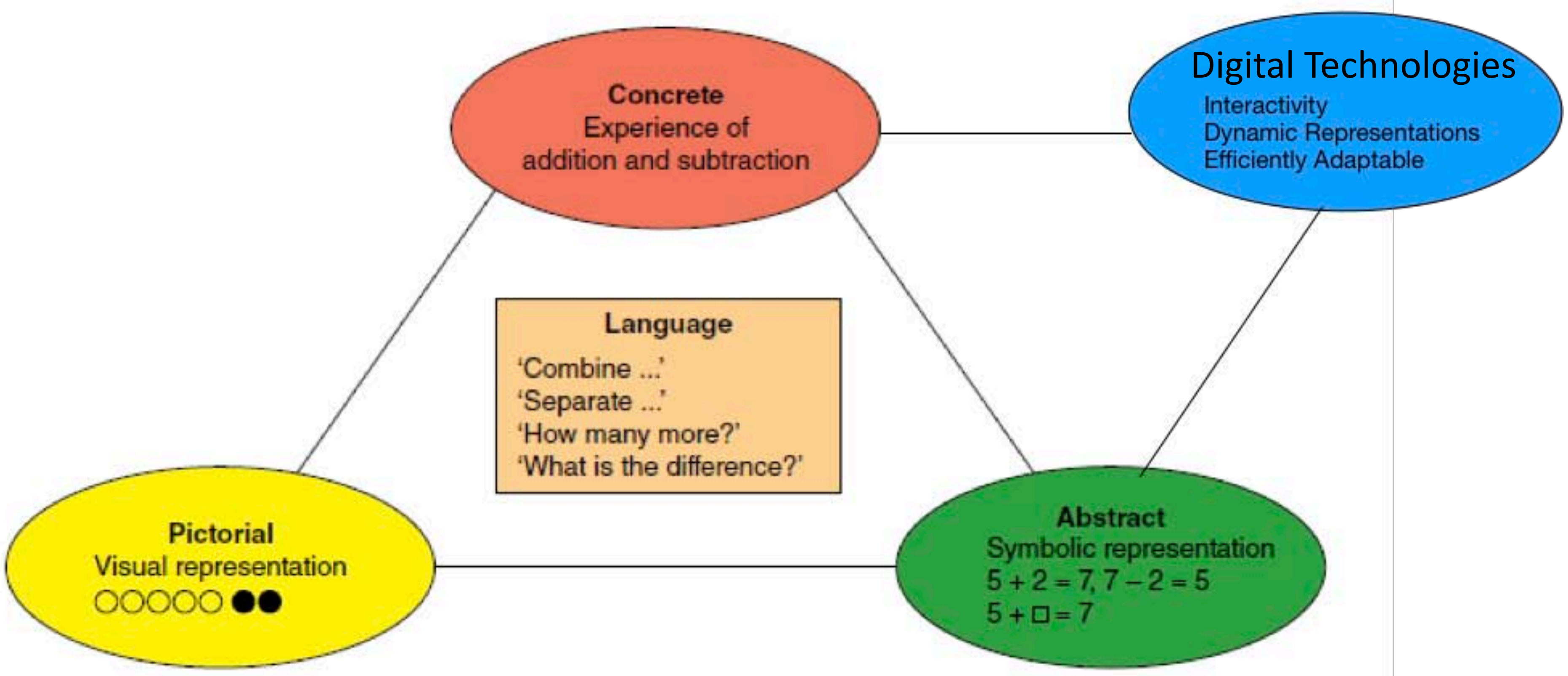
# Why this matters for Mathematics

- Over the last 20 approx. years this is how the teaching of mathematics has been encouraged:



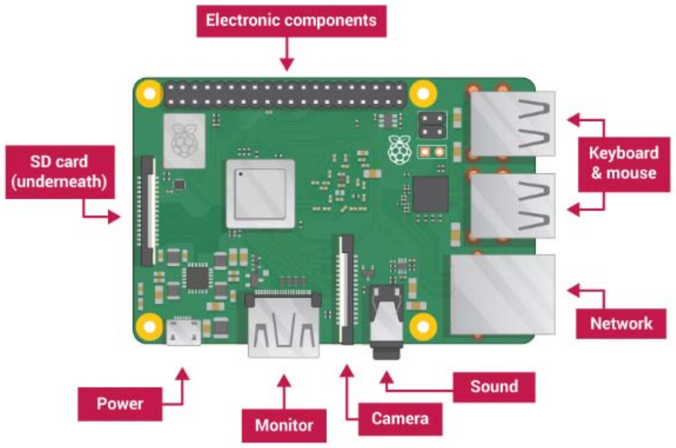

(Reys et al, 2019)

# This is now how the teaching of mathematics should be viewed…

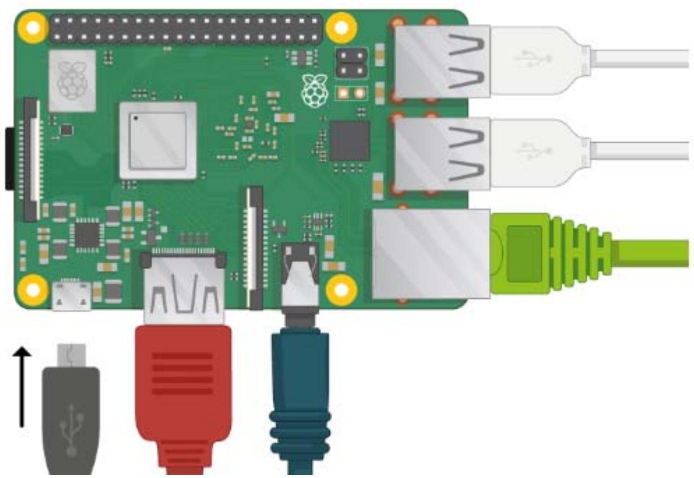


# How can we achieve equity with limited funding?

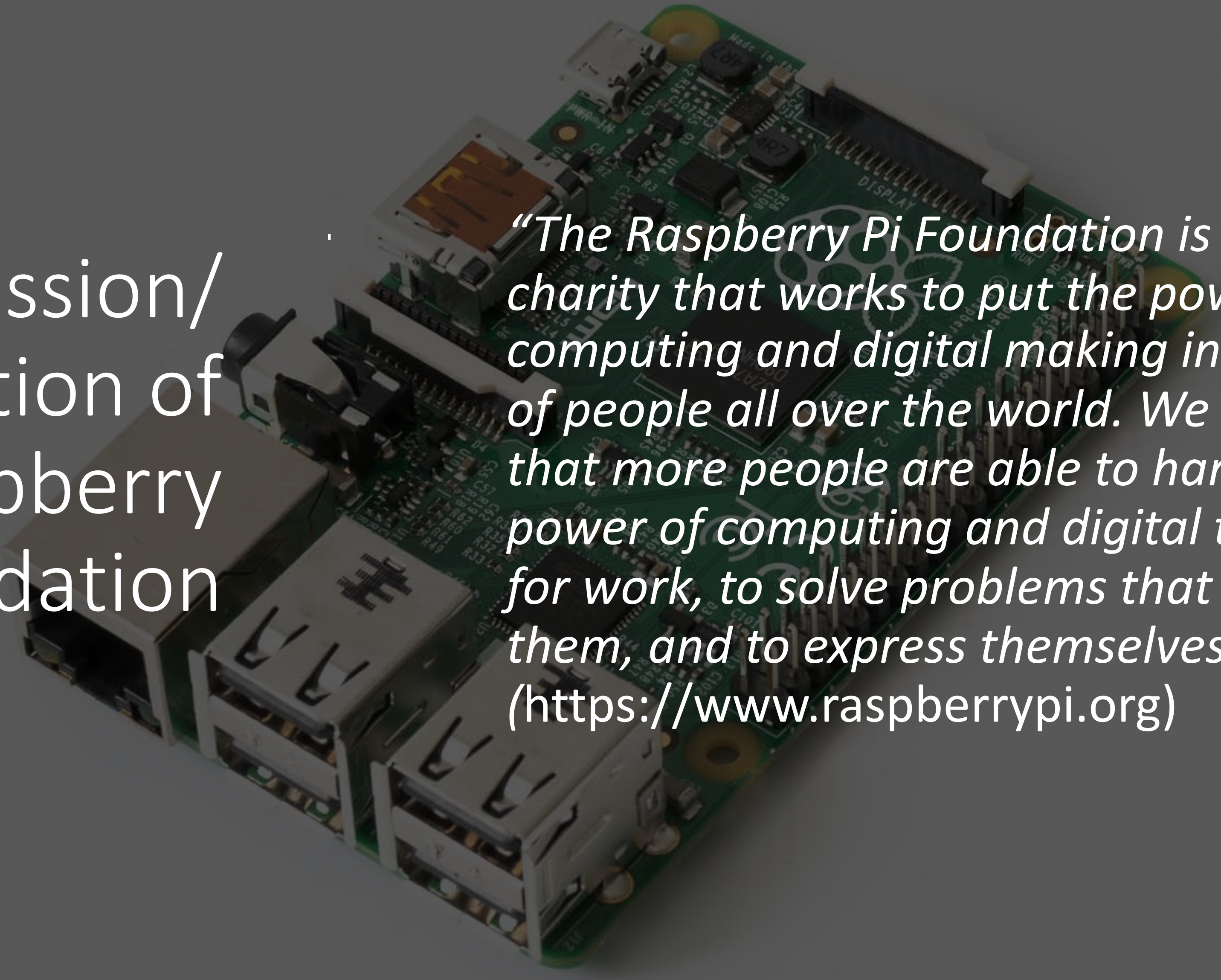
- One Solution: The Raspberry Pi
- A Single Board Computer (SBC)
- Everything a regular computer has – but on one (small) board)
- It has a removable SD card instead of a hard drive
- The SD card has an operating installed on it (Raspbian a derivation of Debian Linux)




- Plug a micro USB power supply into a socket and connect it to you Pi's power port.



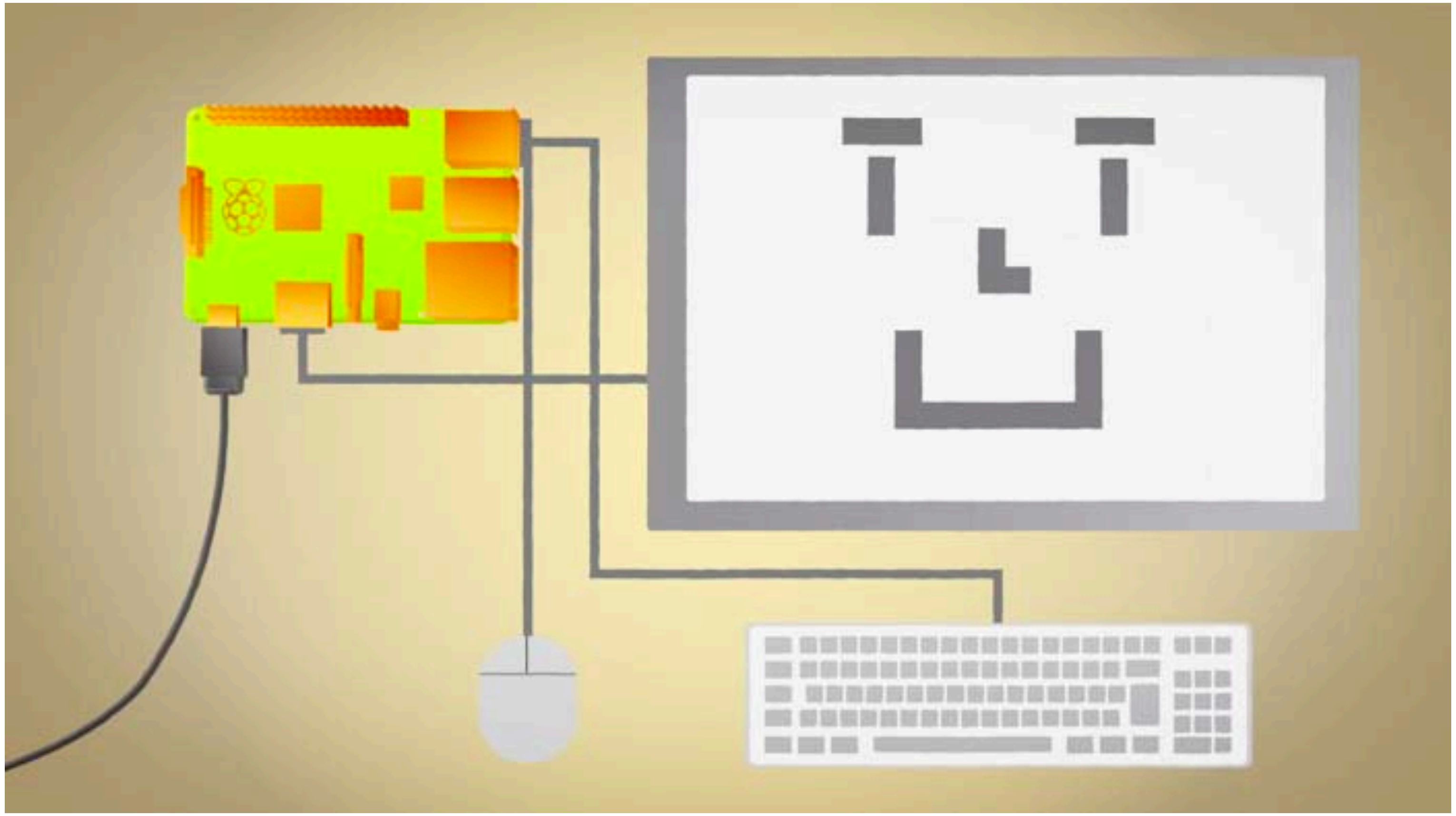
# The Mission/ Ambition of the Raspberry Pi Foundation



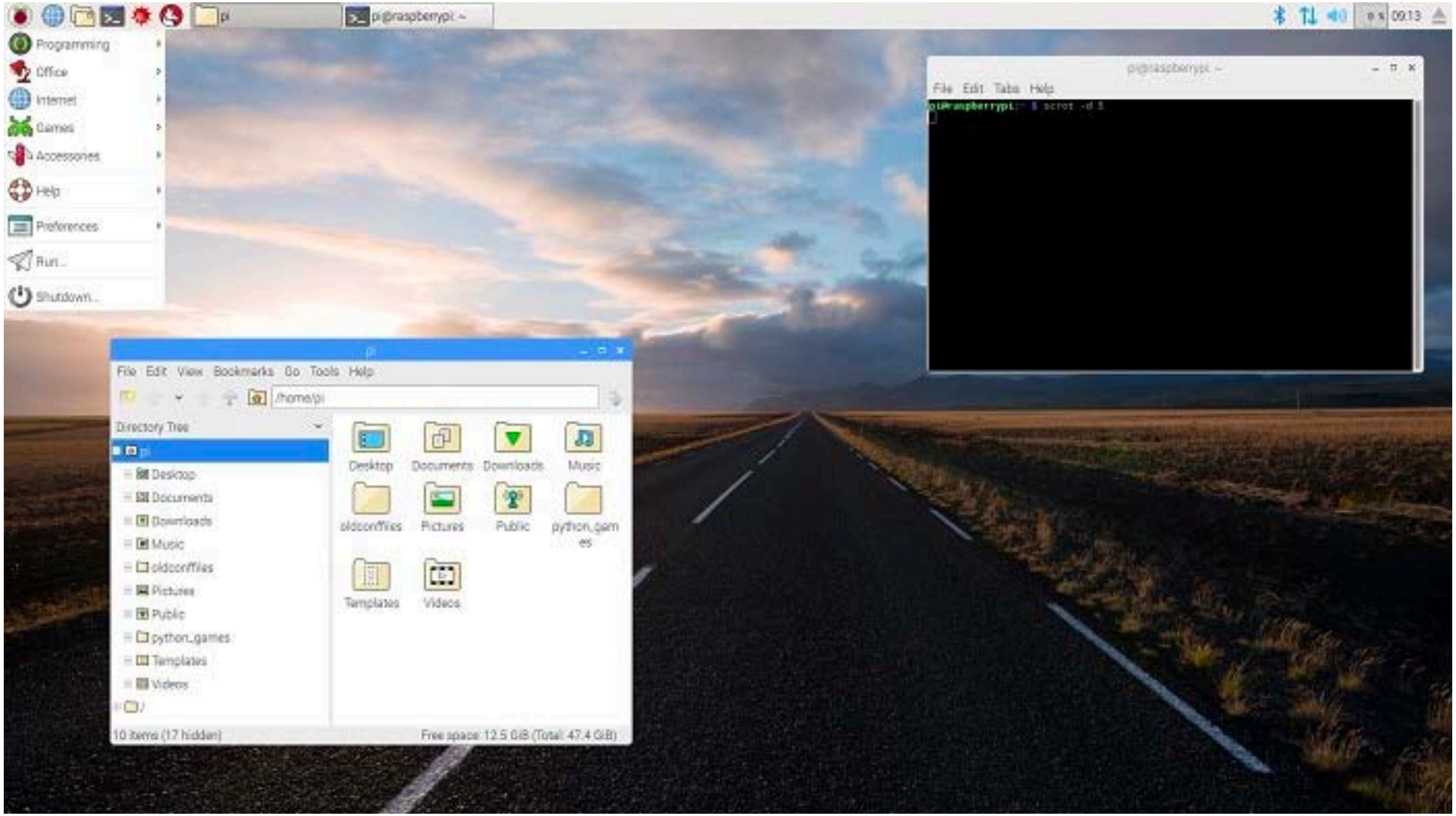
*"The Raspberry Pi Foundation is a UK-based charity that works to put the power of computing and digital making into the hands of people all over the world. We do this so that more people are able to harness the power of computing and digital technologies for work, to solve problems that matter to them, and to express themselves creatively."*
(https://www.raspberrypi.org)

# What do you Need to Run a Raspberry Pi?

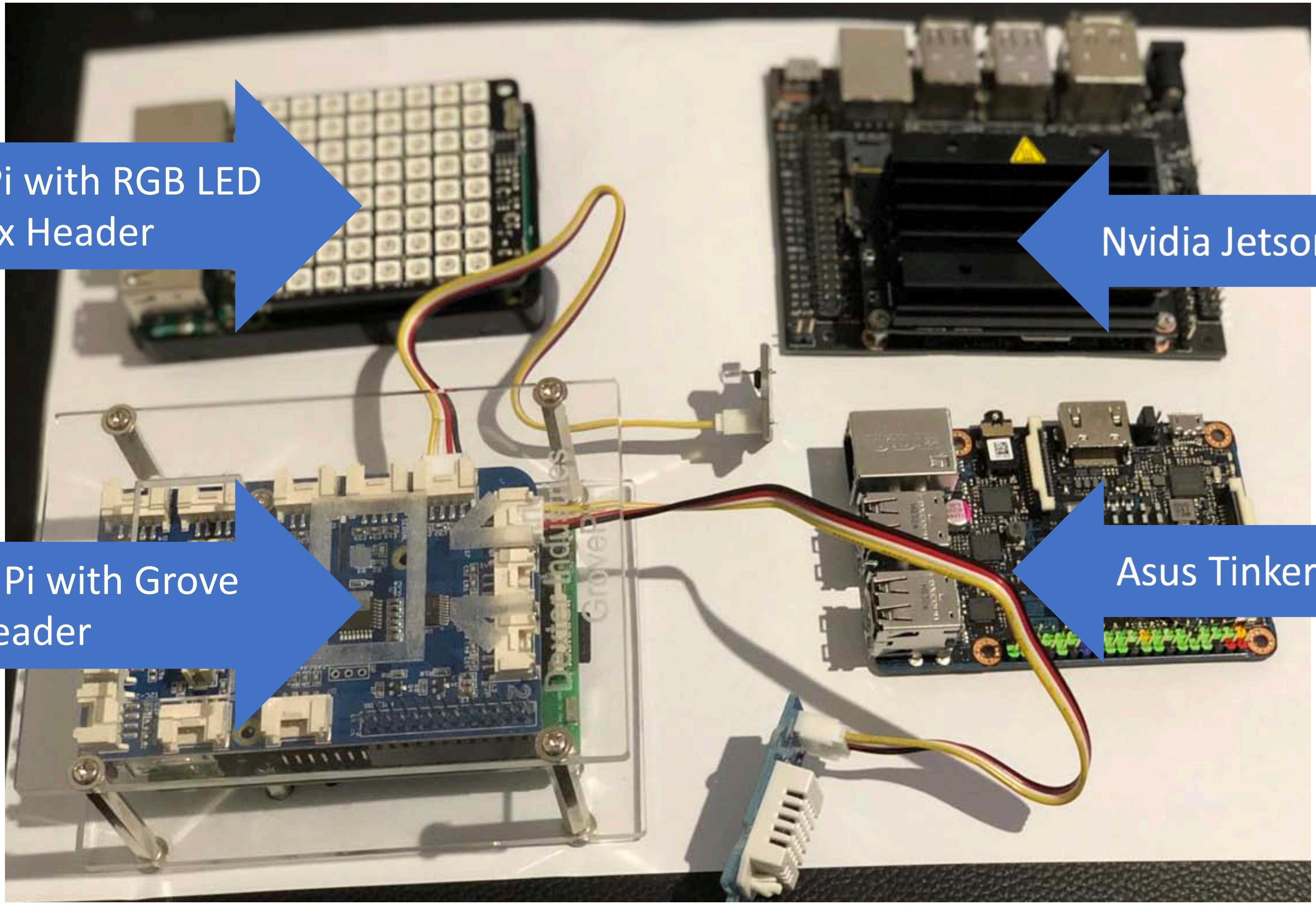
- USB mouse
- USB keyboard
- TV or monitor
- HDMI cable
- Micro USB power cable
- Micro SD card



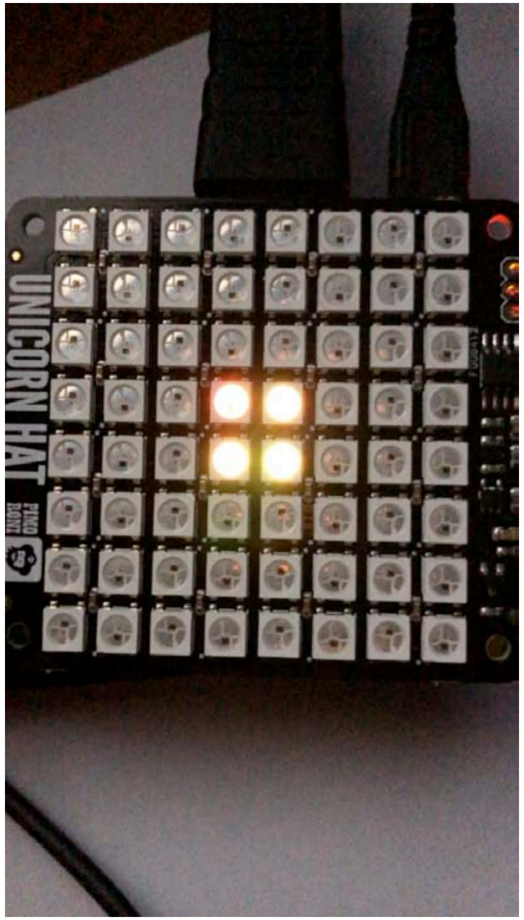
# What the Raspbian Operating System Looks Like:

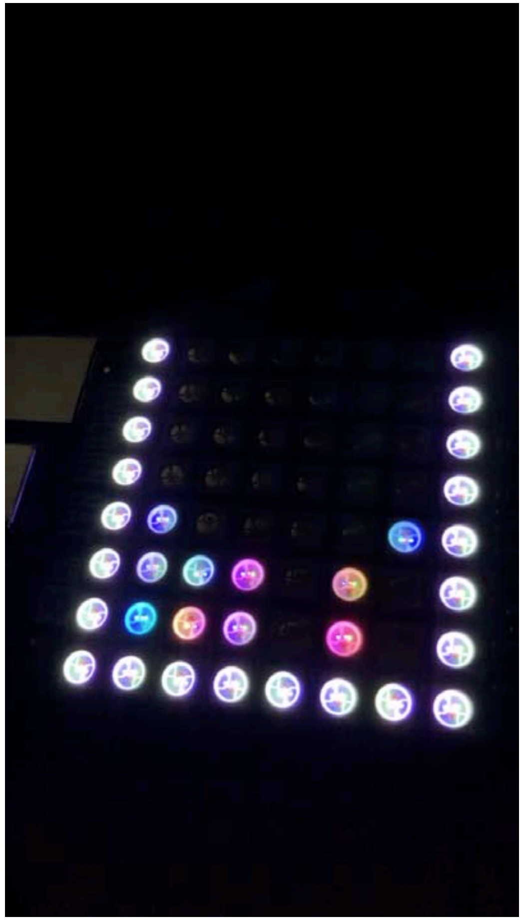


# Raspberri Pis aren't the only SBCs

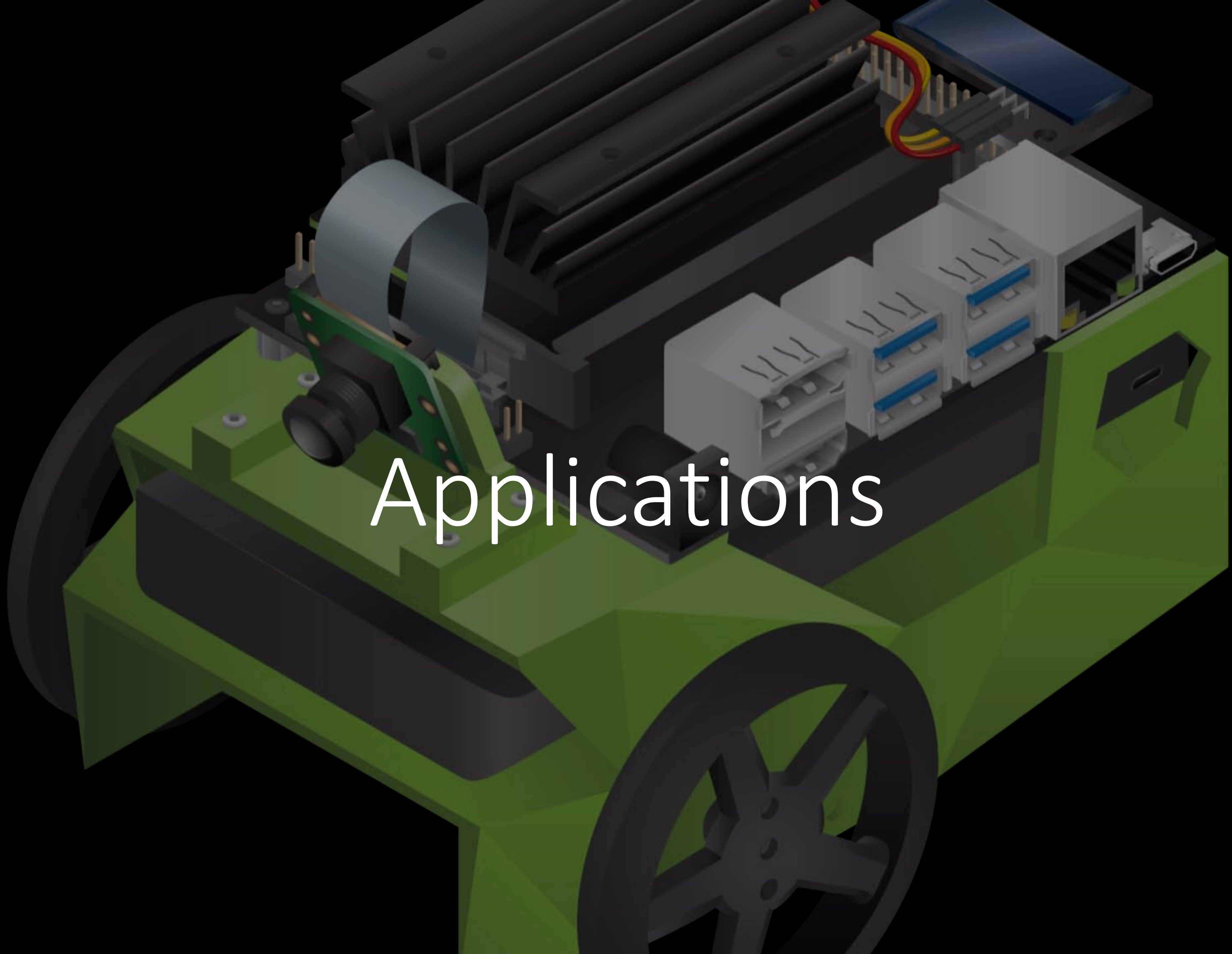


# Applications



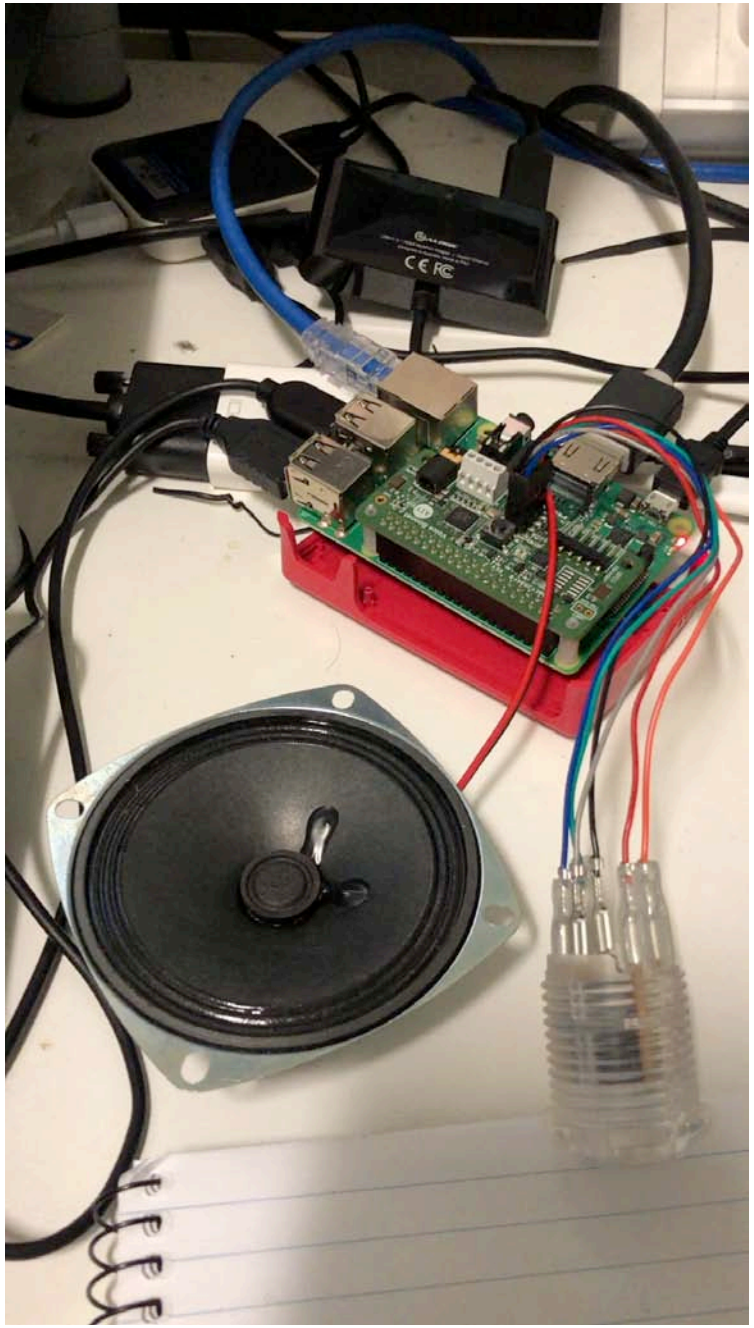



# Applications

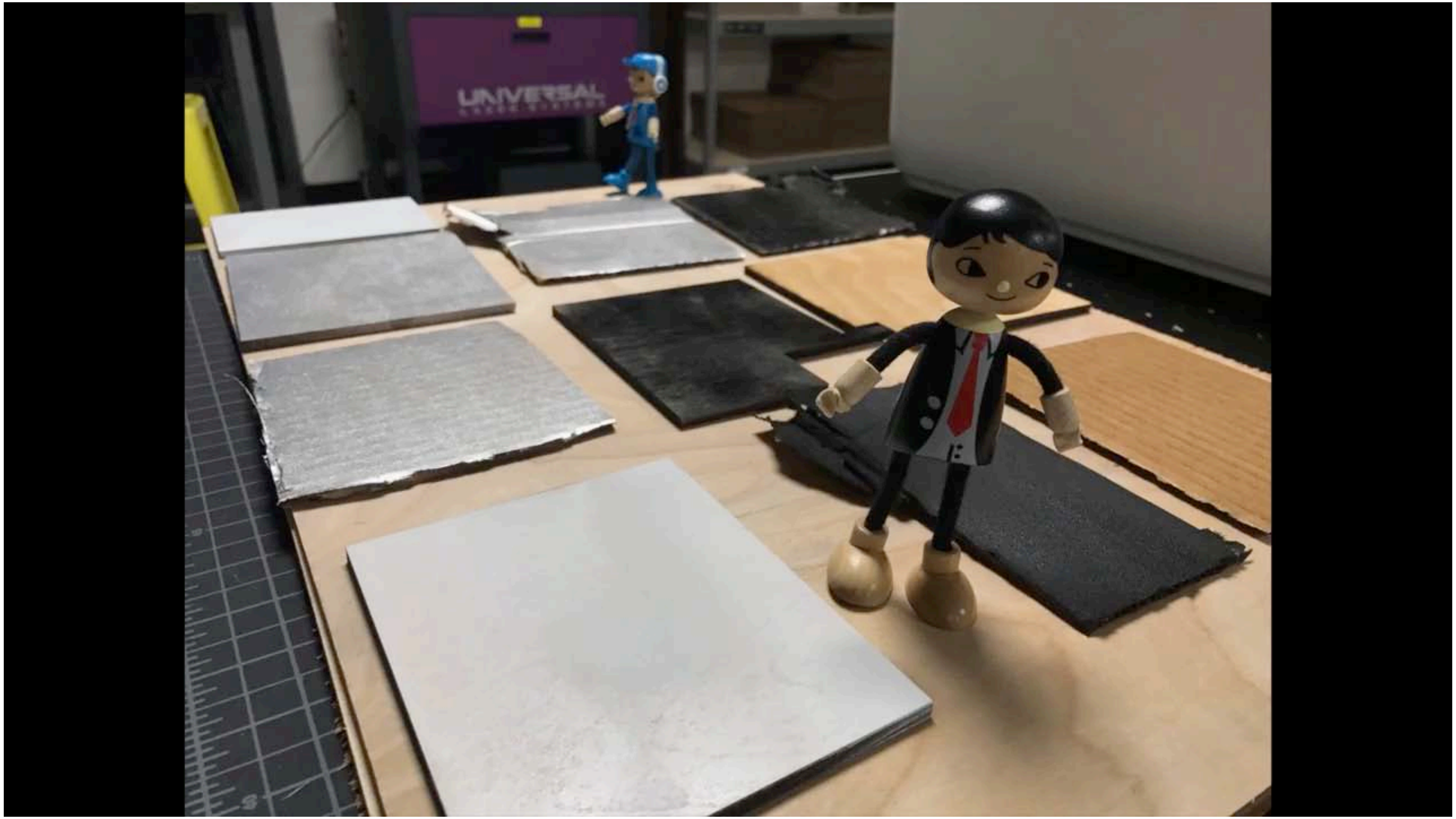


# Google AIY Voice Kit


https://aiyprojects.withgoogle.com/voice/



# You can go as far as you want….



# Why Raspberry Pi?

- $$$ = Equitable (No big corporation is profiting)
- 'Bare-bones' approach allows learners to actually see what the various components do and they work within the system (systems thinking)
- Easy connection of sensors means, many many mathematical applications
- $$$ = Raspbian (Linux derivation) is open source and all of the software it comes free with is too. This includes:
  - Scratch
  - Python IDEs
  - Mine Craft
  - Sonic Pi - Music Coding Software
  - Libre Office – Office Suite
  - … and more

# Why Raspberry Pi?

- Access to GPIO pins means the possibility of ‘physical coding’
- This makes the following all possible:
    - Robotics
    - Sensors and data loggers
    - Artificial Intelligence Applications
- You can also get more user/ younger student friendly versions (see image)


Invest in Professional Learning, not just apps, and techno-gadgets

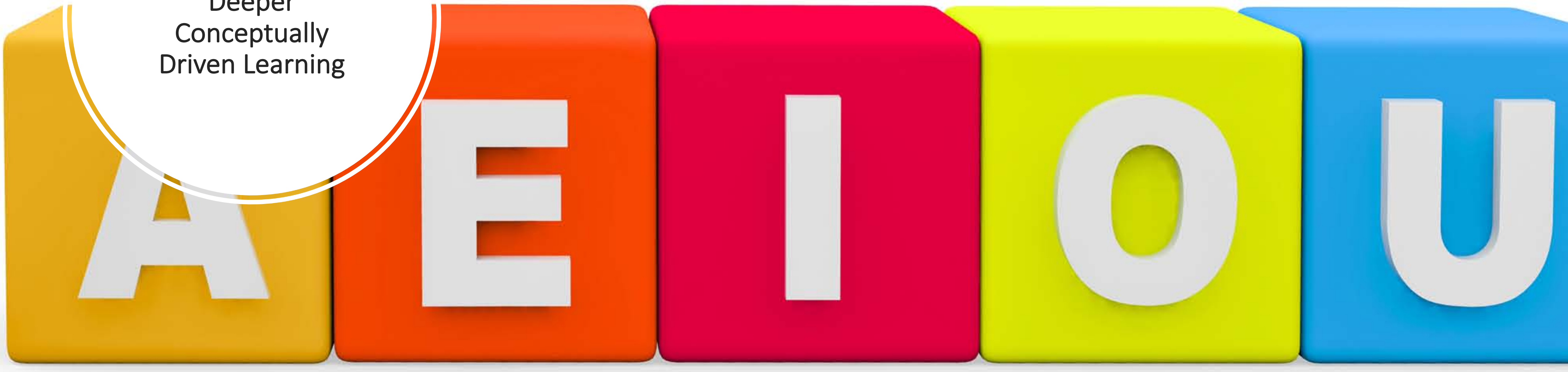
-

# Invest in Professional Learning

Niess (2005) argued that:

*...for technology to become an integral component or tool for learning, science and mathematics preservice teachers must also develop an overarching conception of their subject matter with respect to technology and what it means to teach with technology—Technological Pedagogical Content Knowledge (TPCK)(p. 510).*

Offset Procedural Fluency with Deeper Conceptually Driven Learning



# Offset Procedural Fluency with Deeper Conceptually Driven Learning

Conceptual Understanding can be provided following the advice of Herrington and Kervin (2007):

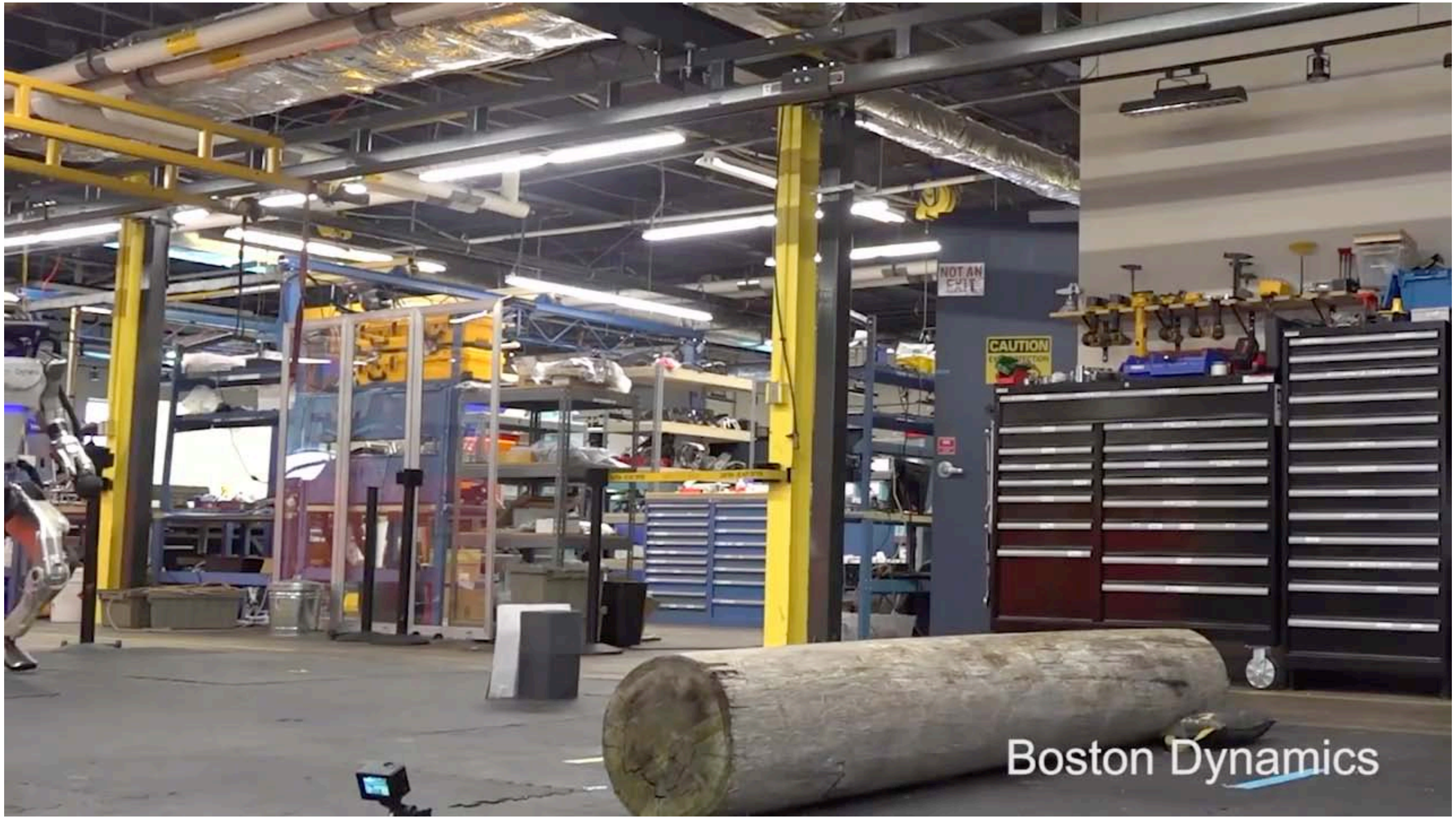
- Provide authentic contexts that reflect the way the knowledge will be used in real life.
- Provide authentic activities.
- Provide access to expert performances and the modelling of processes.
- Support collaborative construction of knowledge.
- Promote reflection to enable abstractions to be formed.
- Promote articulation to enable tacit knowledge to be made explicit.
- Provide coaching by the teacher at critical times, and scaffolding and fading of teacher support.
- Provide for authentic, integrated assessment of learning within the tasks (p.223)

# Focusing on Abstraction: Algorithmic Thinking in the Victorian Curriculum

*With its origins in mathematics, algorithmic thinking refers to logical, sequenced processes that together create a desired outcome. Algorithmic thinking, in relation to technologies, has developed concurrently with computer programming and the micro-processor. At its simplest level, algorithmic thinking can be seen as 2 + 2 = 4.*

*(Blannin & Symons, 2019)*

# Algorithmic Thinking at its Most Sophisticated…



# Algorithmic Thinking in the Victorian Curriculum

## Key points:

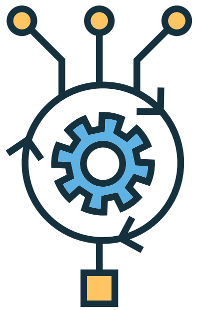
- Focus on helping students to develop their algorithmic/logical thinking
- Not the same as having students memorise algorithms
- Embedded in both the mathematics curriculum and technologies curriculum
- Not the same as Coding
- It's the thinking behind the language = The kind of thinking that a computer could execute

# Algorithmic Thinking in the Victorian Curriculum

- Algorithmic Thinking is comprised of four key areas:

  - Design Thinking,
  - Decomposition,
  - Pattern Recognition and
  - Abstraction.

(Blannin & Symons, 2019)



ALGORITHM

## Some Key Terms

**Algorithm**

- A list of steps to finish a task.

**Block-Based Programming Language**

- Any programming language that lets users create programs by manipulating “blocks” or graphical programming elements, rather than writing code using text. Examples include Code Studio, Scratch, Blockly, and Swift. (Sometimes called visual coding, drag and drop programming, or graphical programming blocks)

**Bug**

- An error in a program that prevents the program from running as expected.

**Debug**

- Finding and fixing problems in an algorithm or program.

**Code**

- The language that programmers create and use to tell a computer what to do.

**Iteration**

- A repetitive action or command typically created with programming loops.

**Loop**

- The action of doing something over and over again.

# Some key terms

**Branching**

- Branching occurs when an algorithm makes a choice to do one of two or more actions depending on sets of conditions and the data provided.

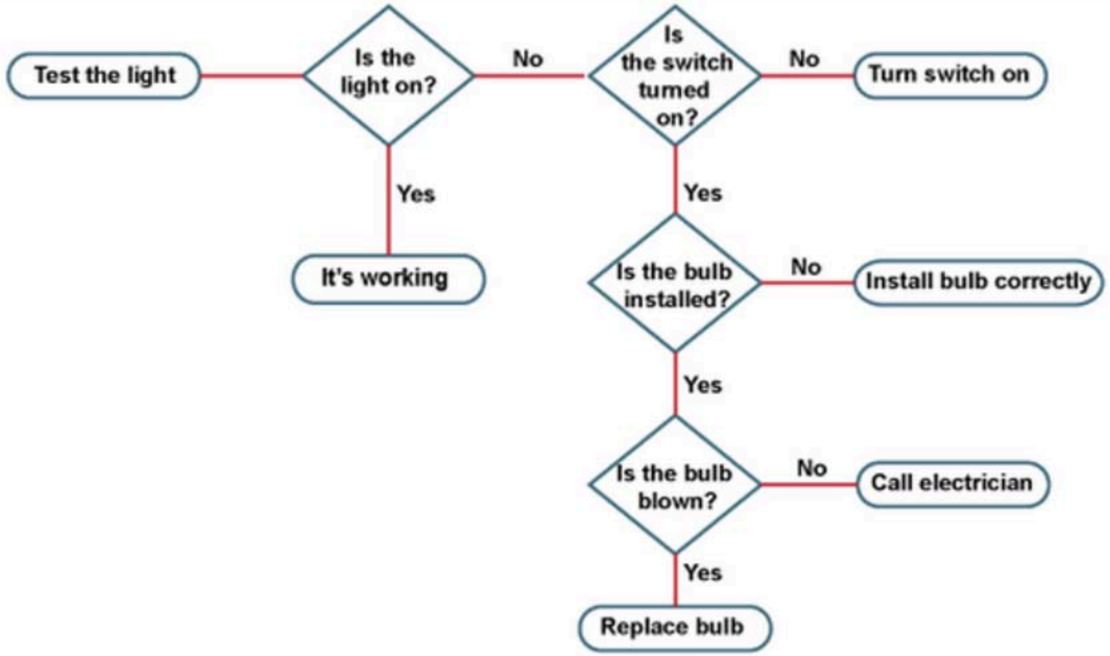



diagram illustrating branching

(VCAA, 2019)

# Algorithms in the Victorian Curriculum: Mathematics

- Strand: Number and Algebra, Sub-strand: Patterns and Algebra

| Level | Content description (mandatory) |
|---|---|
| F | Follow a short sequence of instructions (VCMNA077) |
| 1 | Recognise the importance of repetition of a process in solving problems (VCMNA094) |
| 2 | Apply repetition in arithmetic operations, including multiplication as repeated addition and division as repeated subtraction (VCMNA114) |
| 3 | Use a function machine and the inverse machine as a model to apply mathematical rules to numbers or shapes (VCMNA139) |
| 4 | Define a simple class of problems and solve them using an effective algorithm that involves a short sequence of steps and decisions (VCMNA164) |
| 5 | Follow a mathematical algorithm involving branching and repetition (iteration) (VCMNA194) |
| 6 | Design algorithms involving branching and iteration to solve specific classes of mathematical problems (VCMNA221) |

# Algorithms in the Victorian Curriculum: Digital Technologies

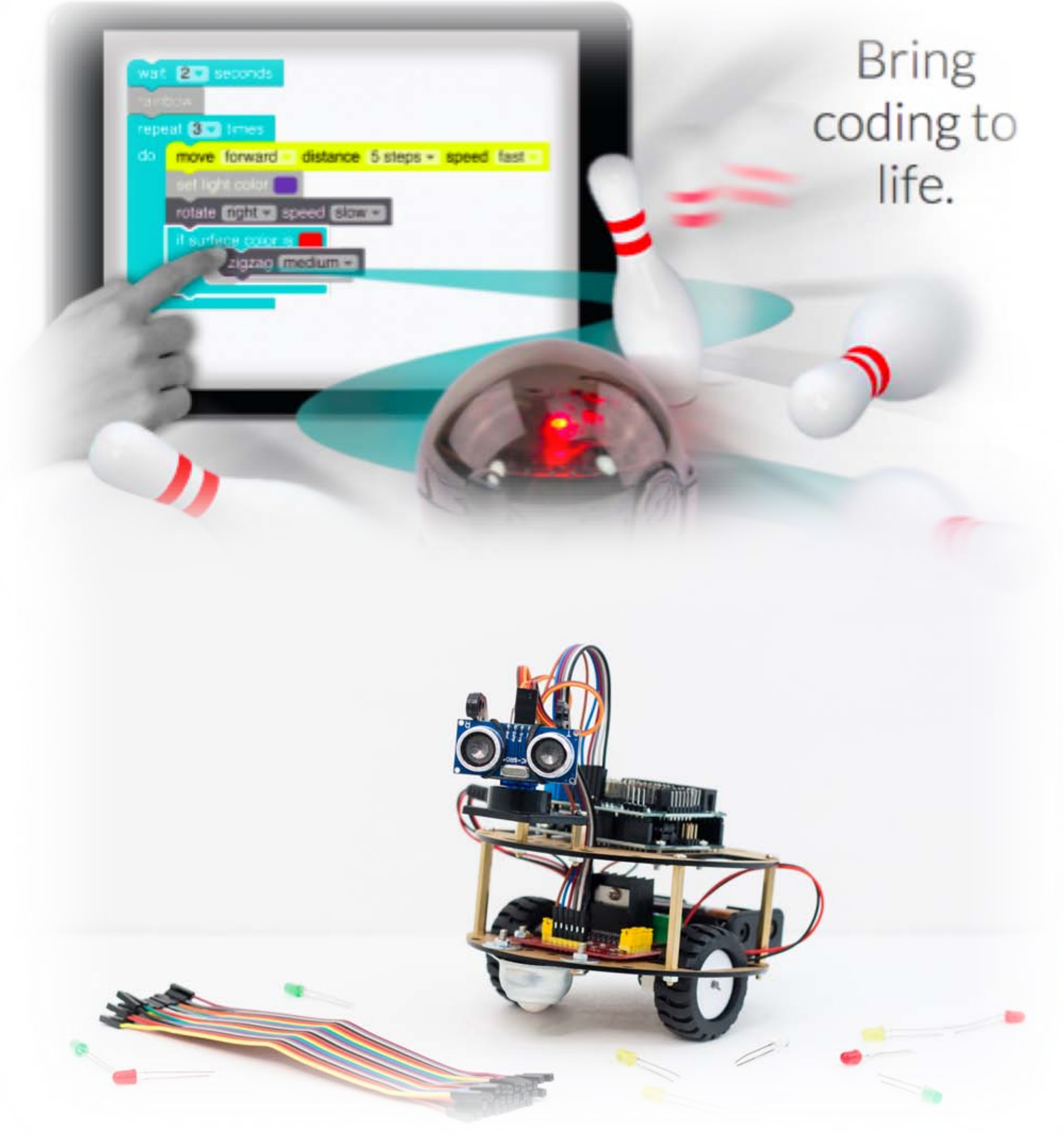
- Creating Digital Solutions

| Level | Content Description |
| --- | --- |
| F/1/2 | Follow, describe and represent a sequence of steps and decisions (algorithms) needed to solve simple problems (VCDTCD017) |
| 3/4 | Define simple problems, and describe and follow a sequence of steps and decisions involving branching and user input (algorithms) needed to solve them(VCDTCD023) |
| 5/6 | Design, modify and follow simple algorithms represented diagrammatically and in English, involving sequences of steps, branching, and iteration(VCDTCD032) |

THE UNIVERSITY OF MELBOURNE

# Approaches to Developing Algorithmic Thinking: Codable Robots

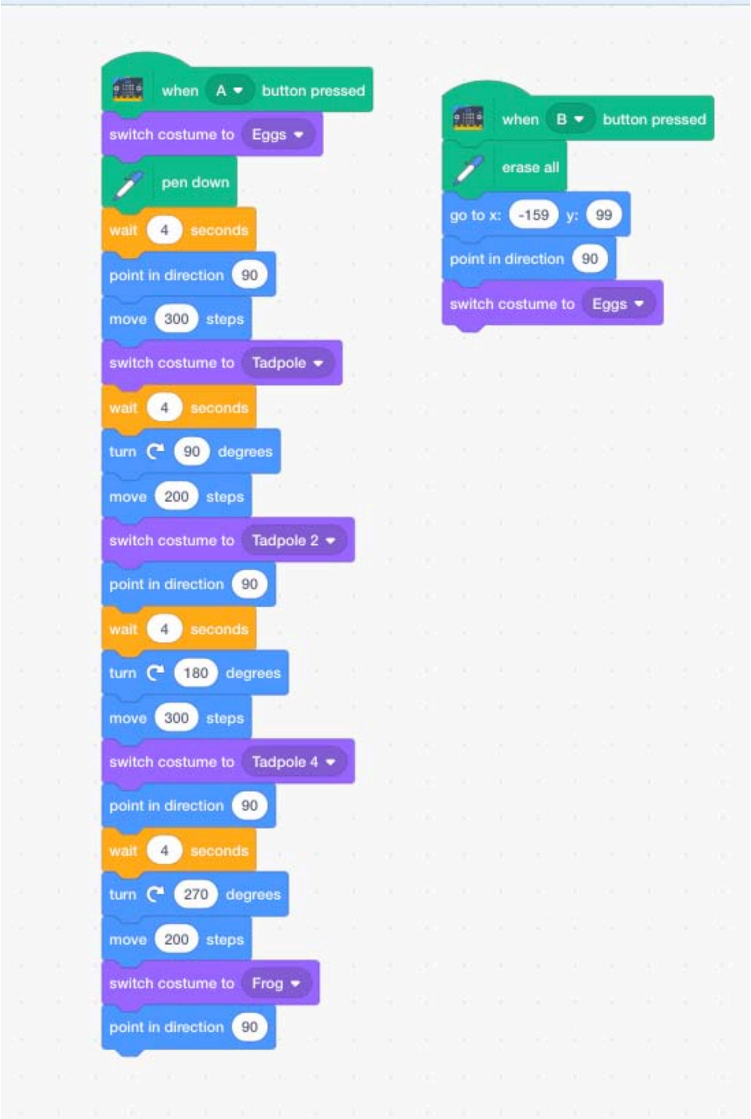
- Relevant to EC and primary years
- Tasks can be scaled up to be more focussed on shape and location
  - More complex shapes
  - Closer links to Digital Technologies
- Basic principles to be consistently developed:
  - experimentation
  - verifying and debugging where necessary
  - recording and representing
  - comparing and discussing
  - evaluating and generalising

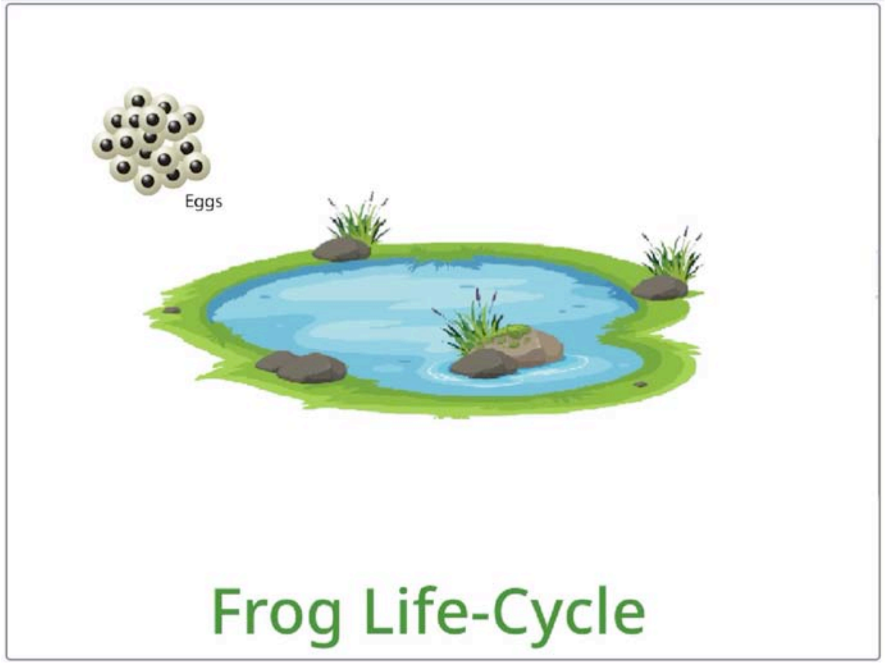


# Grace with Beebots

- Learner Age 4: Discuss Conceptual Understanding (Deep Learning) being developed
- Discuss: Questioning Techniques

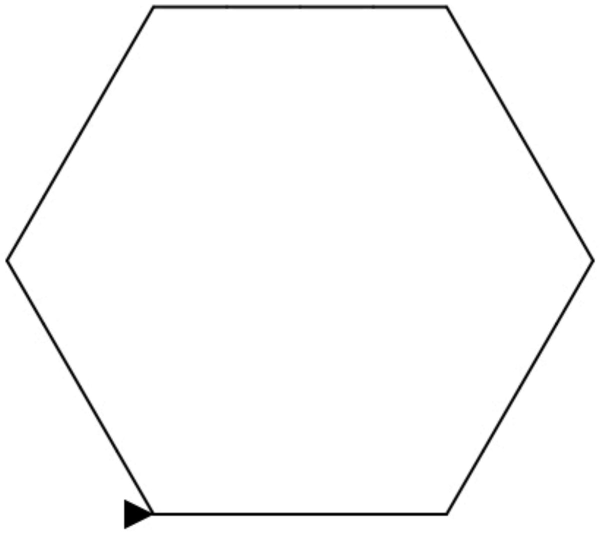
# Approaches to Developing Algorithmic Thinking: Scratch – Frog Life-Cycle




TPS: What understandings from across the disciplines would this support the development of?

```python
import turtle
Jim = turtle.Turtle()
for i in range (6):
  Jim.forward(100)
  Jim.left(60)
```



# Approaches to Developing Algorithmic Thinking: Python

# Programming Shapes with Python

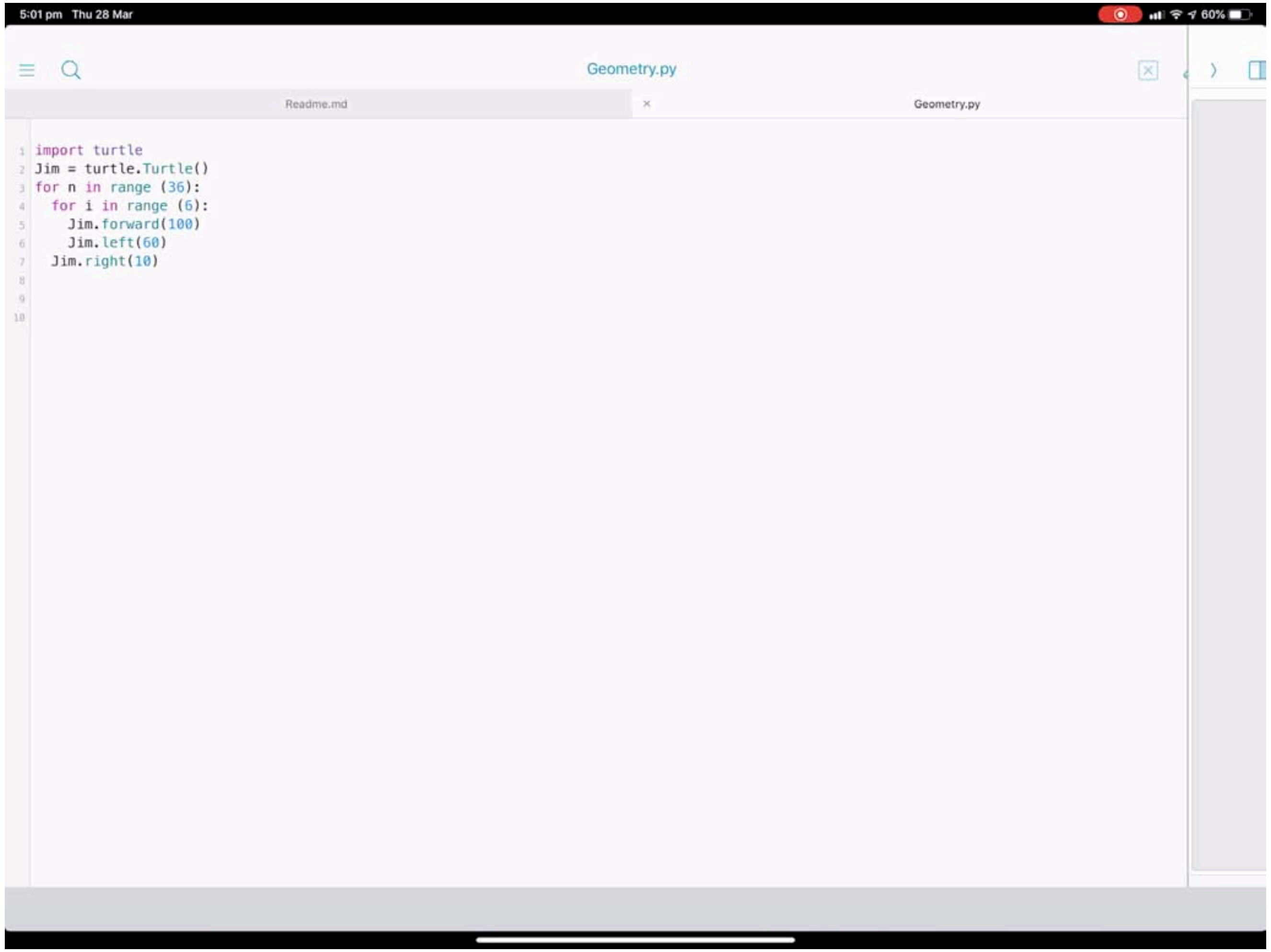
How would you alter the code to make a decagon?

```
import turtle
Jim = turtle.Turtle()
for i in range (6):
  Jim.forward(100)
  Jim.left(60)
```

```
import turtle
Bruce = turtle.Turtle()
for i in range (10):
    Bruce.forward(50)
    Bruce.left(36)
Bruce.penup()
```

# Approaches to Developing Algorithmic Thinking: Python

```python
import turtle
Jim = turtle.Turtle()
for n in range (36):
  for i in range (6):
    Jim.forward(100)
    Jim.left(60)
  Jim.right(10)
```

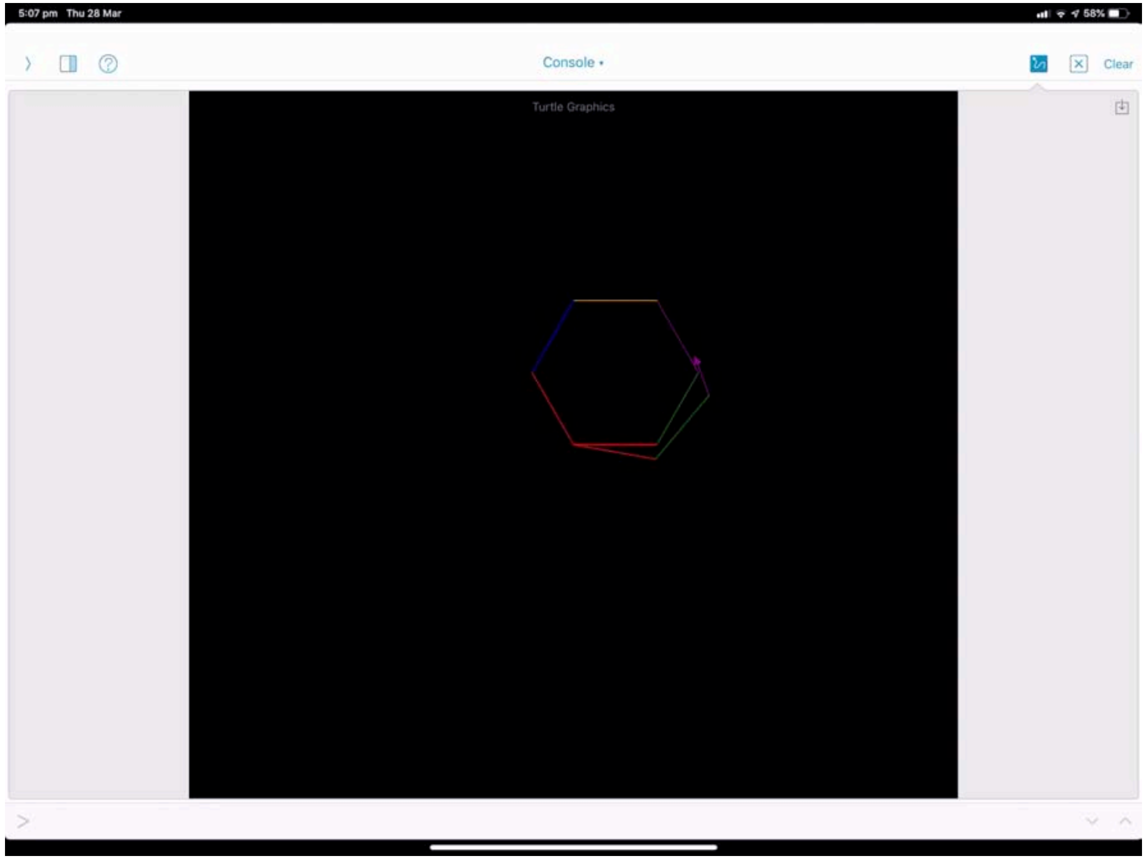


# Approaches to Developing Algorithmic Thinking: Python

```python
import turtle
Jim = turtle.Turtle()
turtle.bgcolor('black')

colors = ['red', 'green', 'purple', 'orange', 'blue', 'red']
for n in range (36):
  for i in range (6):
    Jim.color(colors[i])
    Jim.forward(100)
    Jim.left(60)
  Jim.right(10)

```



# Approaches to Developing Algorithmic Thinking: Python

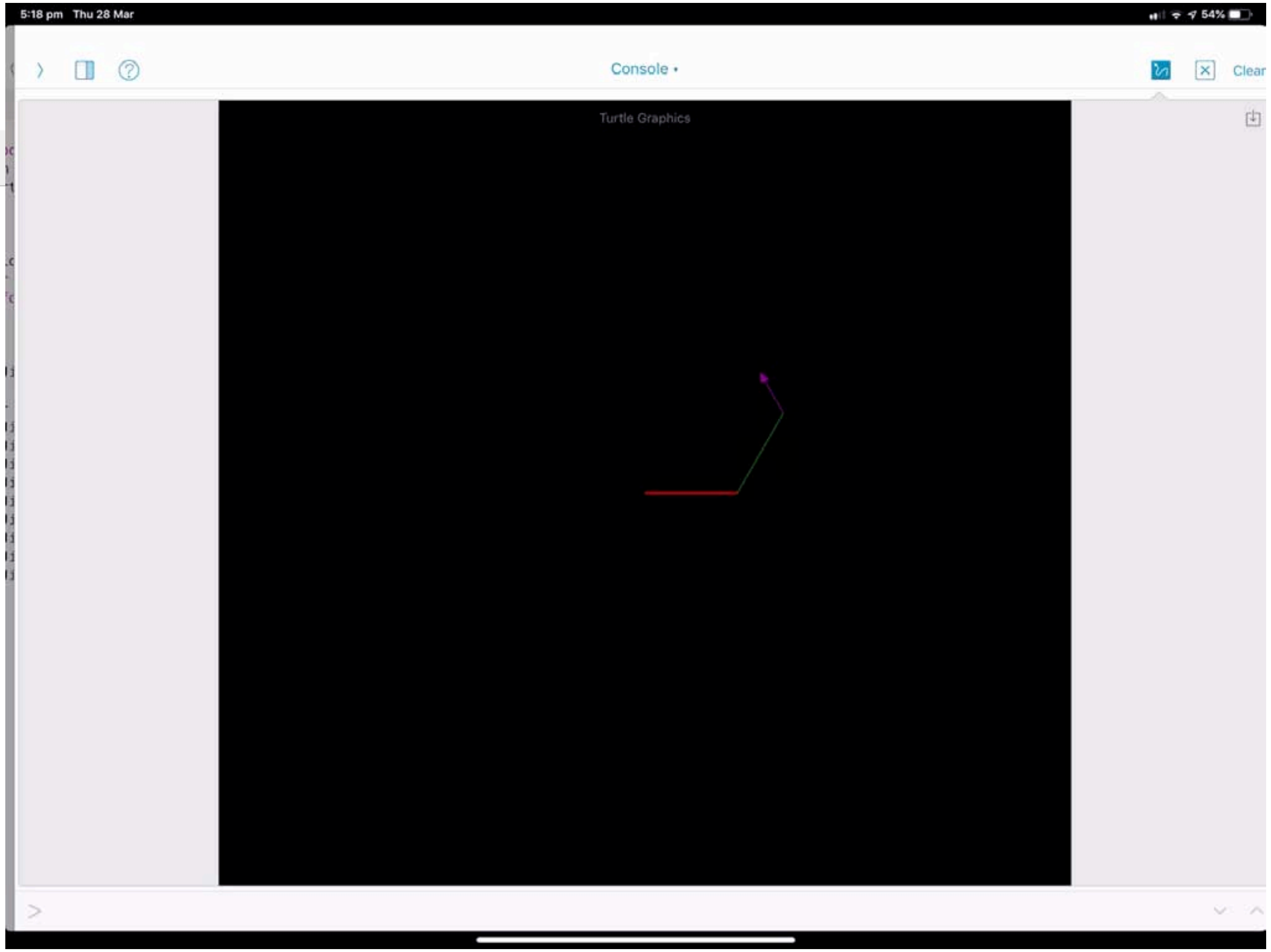
Readme.md

```
import turtle
Jim = turtle.Turtle()
turtle.bgcolor('black')



colors = ['red', 'green', 'purple', 'orange', 'blue', 'red']
for n in range (36):
  for i in range (6):
    Jim.color(colors[i])
    Jim.forward(100)
    Jim.left(60)
  Jim.right(10)

for i in range (36):
  Jim.penup()
  Jim.forward(220)
  Jim.color('white')
  Jim.pendown()
  Jim.circle(5)
  Jim.penup()
  Jim.backward(220)
  Jim.right(10)
  Jim.hideturtle()
```




Discuss: What understandings from across the disciplines would this support the development of?

# Victorian Mathematics Curriculum Links?

Strand: Measurement and Geometry

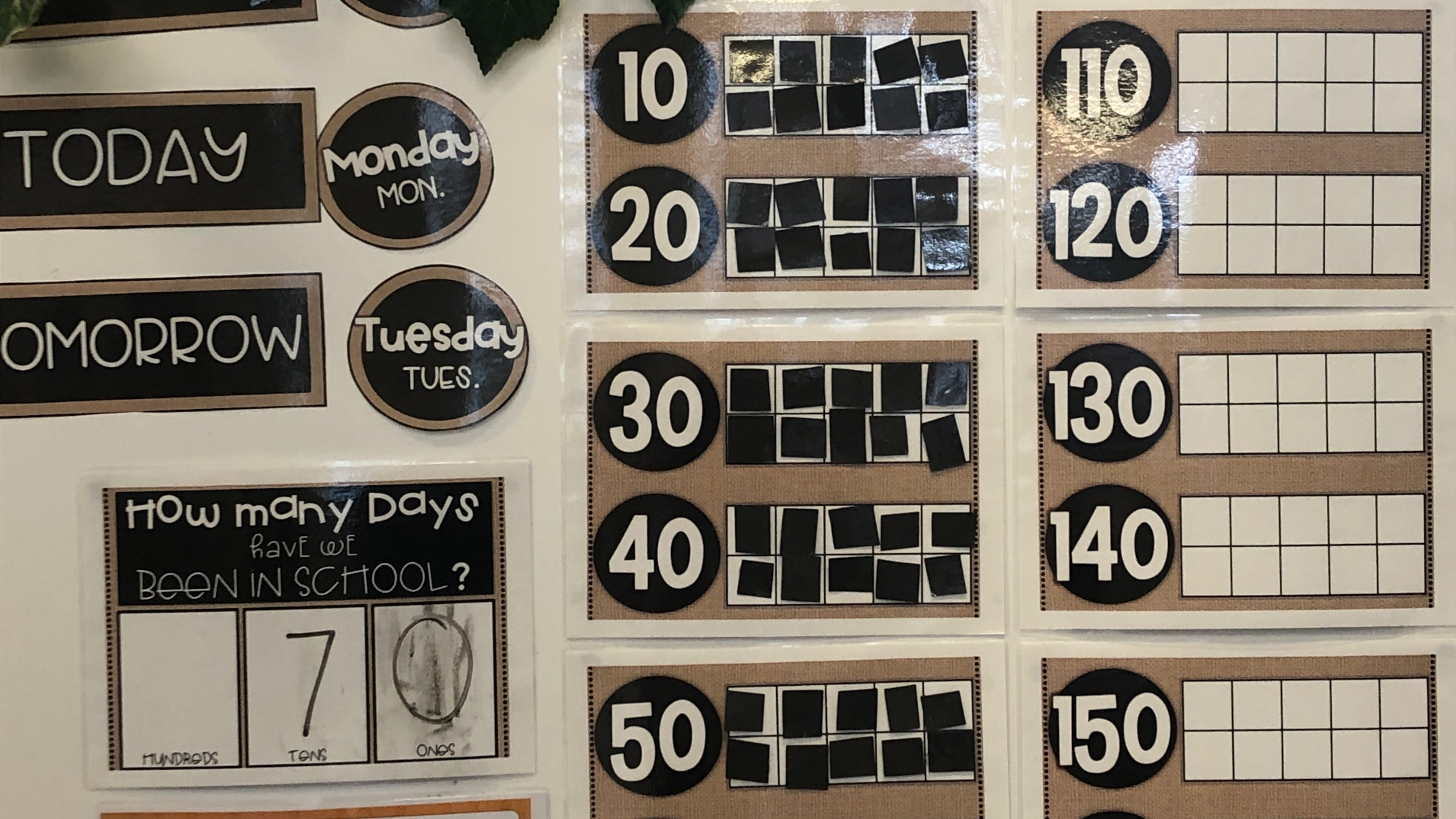
| Year Level | Content Description |
|---|---|
| 5 | Describe translations, reflections and rotations of two-dimensional shapes. Identify line and rotational symmetries (VCMMG200) |
| 6 | Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles. Use results to find unknown angles (VCMMG231) |

# Victorian Mathematics Curriculum Links?

Strand: Number and Algebra, Sub-strand: Patterns and Algebra

| Level | Content description (mandatory) |
|---|---|
| F | Follow a short sequence of instructions (VCMNA077) |
| 1 | Recognise the importance of repetition of a process in solving problems (VCMNA094) |
| 2 | Apply repetition in arithmetic operations, including multiplication as repeated addition and division as repeated subtraction (VCMNA114) |
| 3 | Use a function machine and the inverse machine as a model to apply mathematical rules to numbers or shapes (VCMNA139) |
| 4 | Define a simple class of problems and solve them using an effective algorithm that involves a short sequence of steps and decisions (VCMNA164) |
| 5 | Follow a mathematical algorithm involving branching and repetition (iteration) (VCMNA194) |
| 6 | Design algorithms involving branching and iteration to solve specific classes of mathematical problems (VCMNA221) |

Use Interactive Devices Interactively


TODAY
Monday
MON.
OMORROW
Tuesday
TUES.
How many Days
have we
Been in SCHOOL?
7
0
HUNDREDS
TENS
ONES
10
20
30
40
50
110
120
130
140
150

Notes
You're going to TEAM KIDS after school today...
We have a birthday today...
YESTERDAY
Sunday
TODAY
Monday
MON.
TOMORROW
Tuesday
TUES.
Maxwell
Oscar
Neve
Cleo
This week
Wednesday
Show and tell
library
How many Days have we Been in School?
7
HUNDREDS
TENS
ONES
2-DIGIT PLACE VALUE
TENS
ONES
Days of School
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
weekly WEATHER FORECAST CHART
Monday
Tuesday
Thursday
Friday
SMART

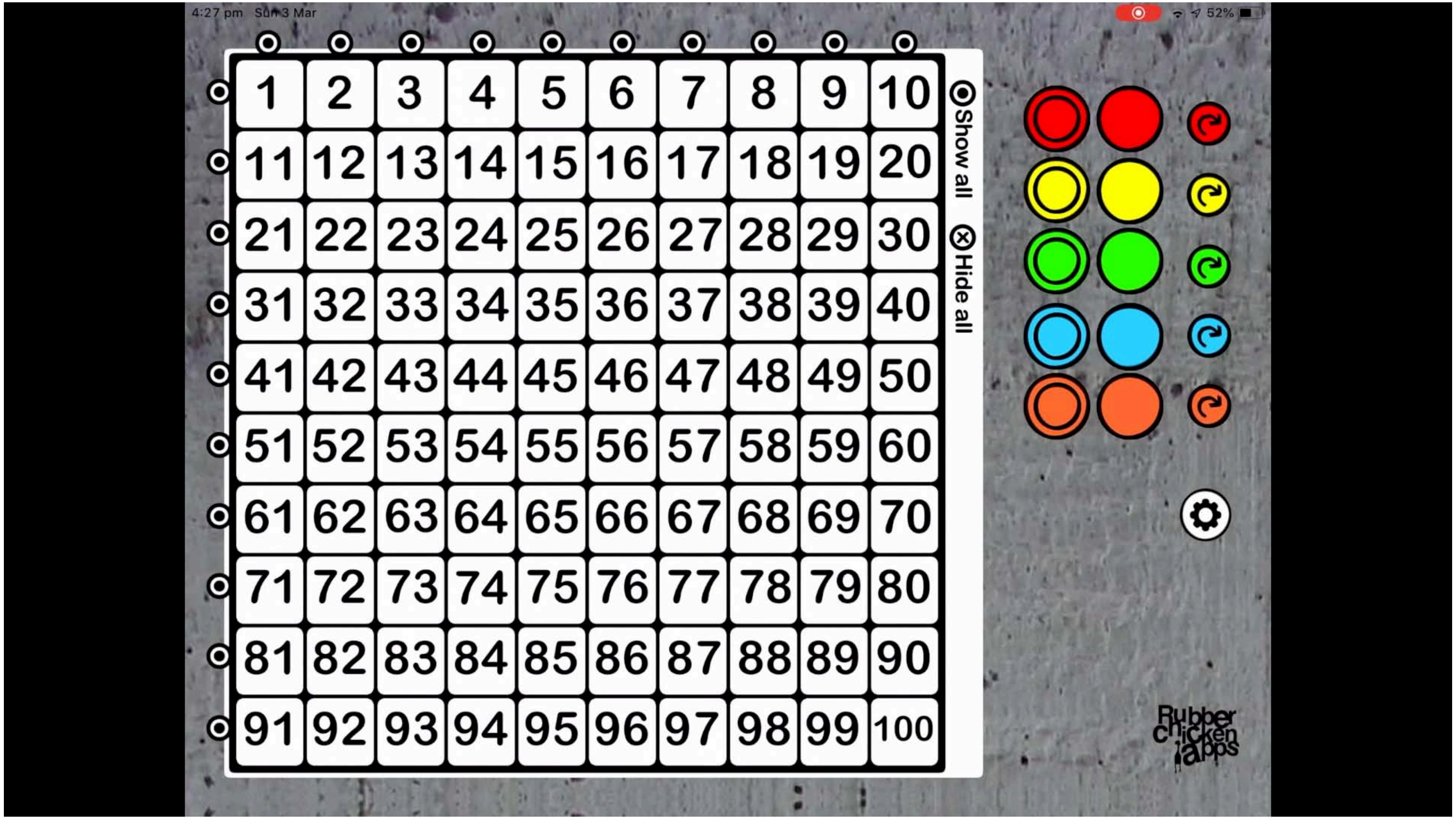
# Interactive Whiteboards – Then…

- Zevenbergen and Lerman (2007) raise questions about how these tools are utilized within the classroom.
- In Australian schools these devices were quickly embraced, often without significant pedagogical change.
- Zevenbergen & Lerman (2007) point to teachers' reliance on pre-prepared packages and lessons for the IWB, and the adherence to these lessons limiting teachers' adaption to their students' particular learning needs.
- They suggest that the 'seductive' quality of the device can capture students' attention in the short term but may not lead to improved learning.

# … and Now

- In the over 10 years since their research findings were published one might wonder if a possible 'novelty effect' may have worn off, allowing for the true pedagogical potential of the tool to be realized.
- Unfortunately, Sheffield (2015) still reports a reluctance of primary/ elementary school teachers to move beyond the unidirectional use of an IWB as purely a data projector.
- Little use is made of their interactivity, arguably the IWB's most potentially transformative capability.

# So what does interactivity look like?





100s Board

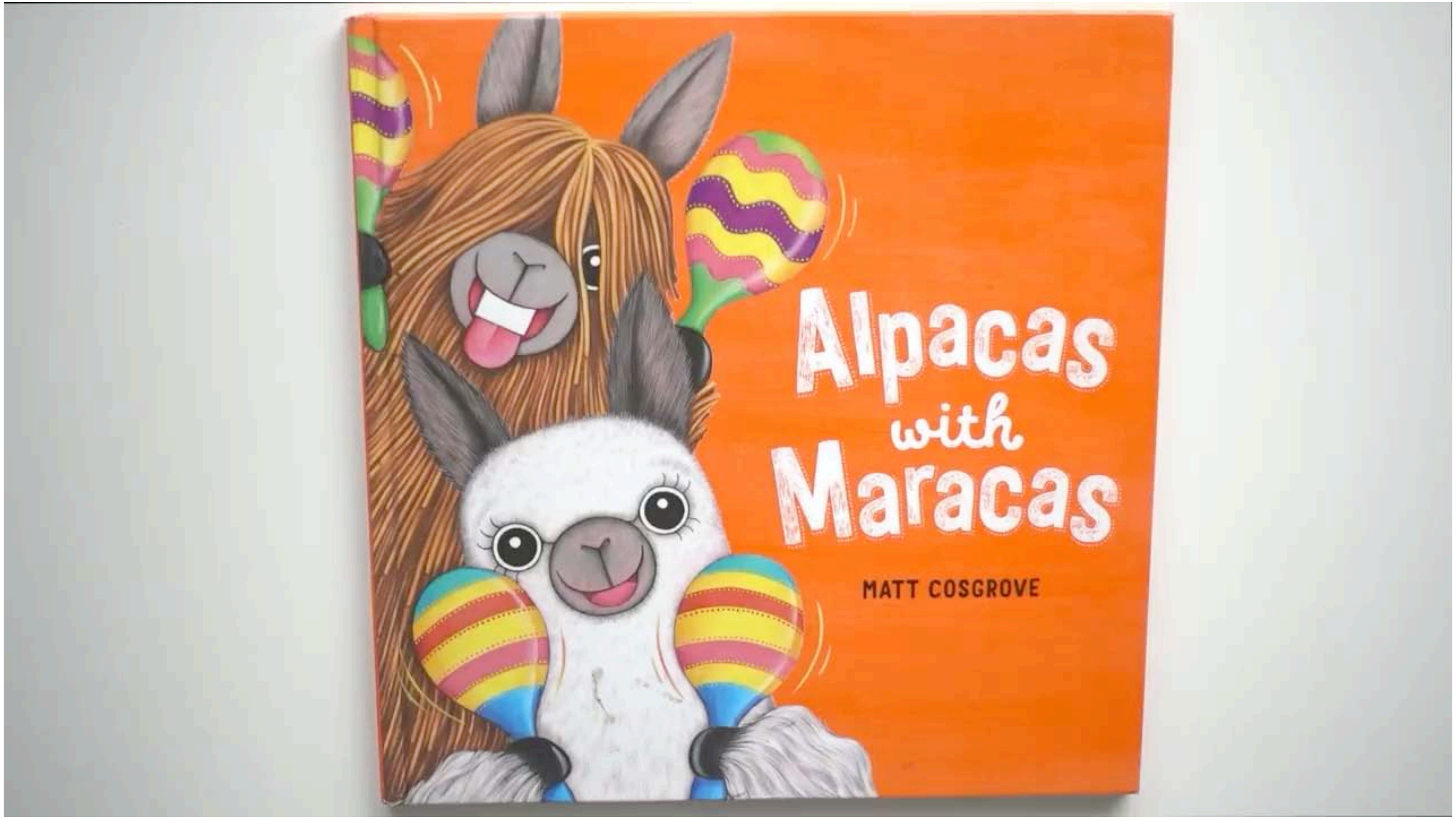
- What is the technology offering us here?
- Is there anything that we can do that we would not be able to achieve without the technology?
- Are there other factors that enhance how effective the tool is?

# Understanding: Number & Algebra
# Counting from 101 to 200

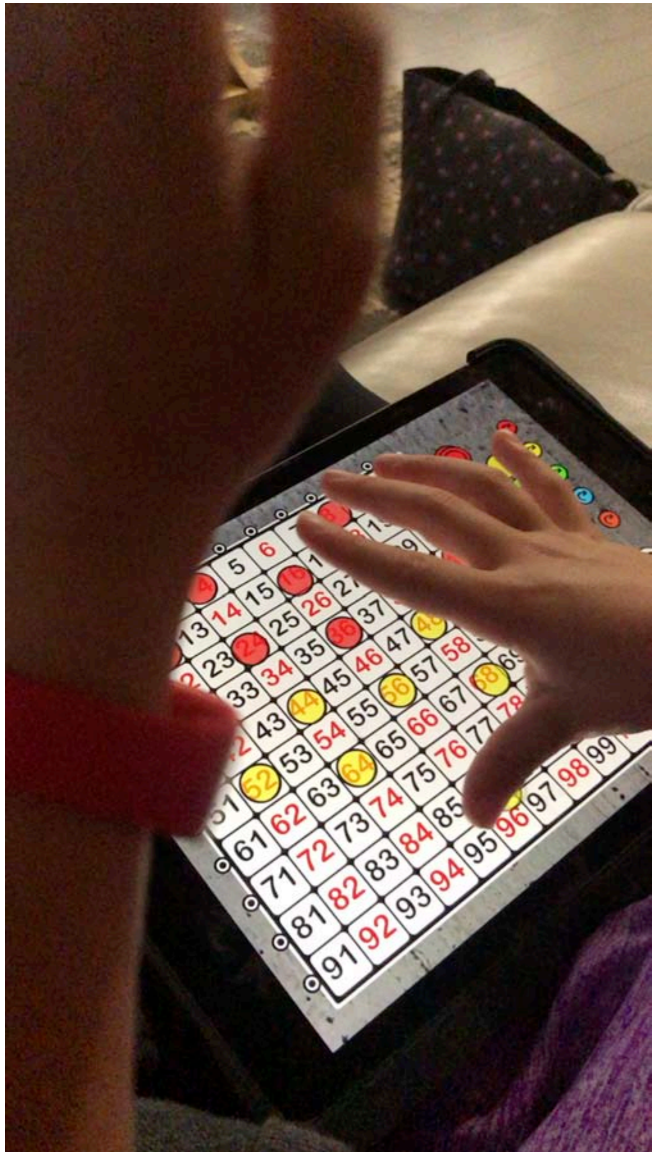

100s Board

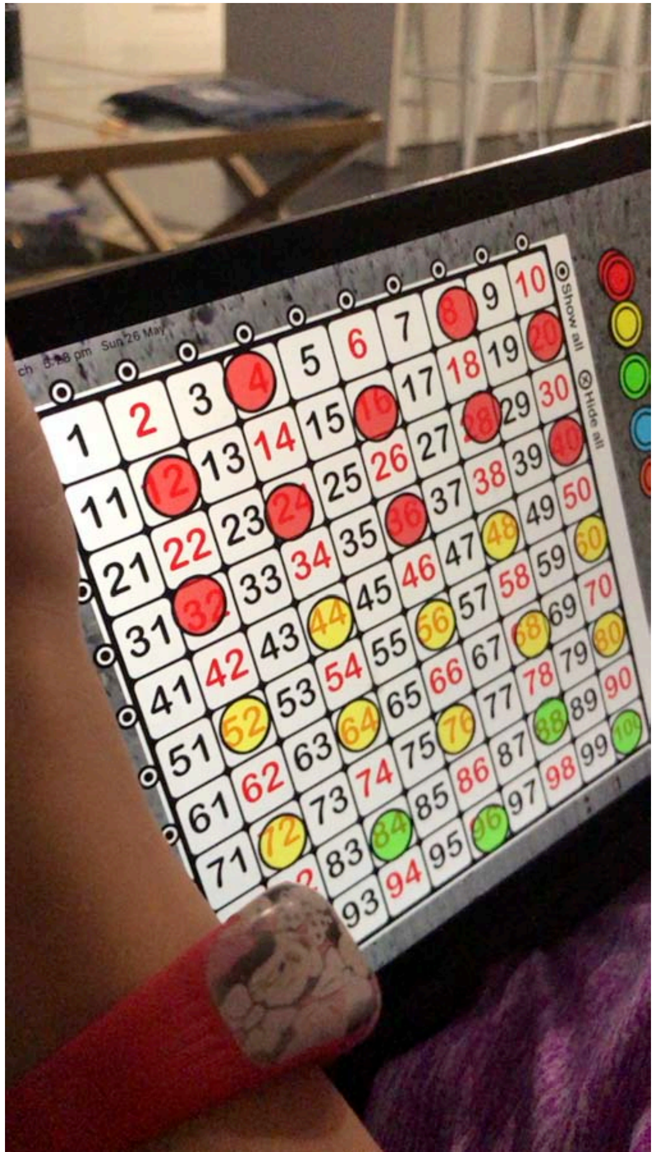
- What is the technology offering us here?
- Is there anything that we can do that we would not be able to achieve without the technology?
- Are there other factors that enhance how effective the tool is?

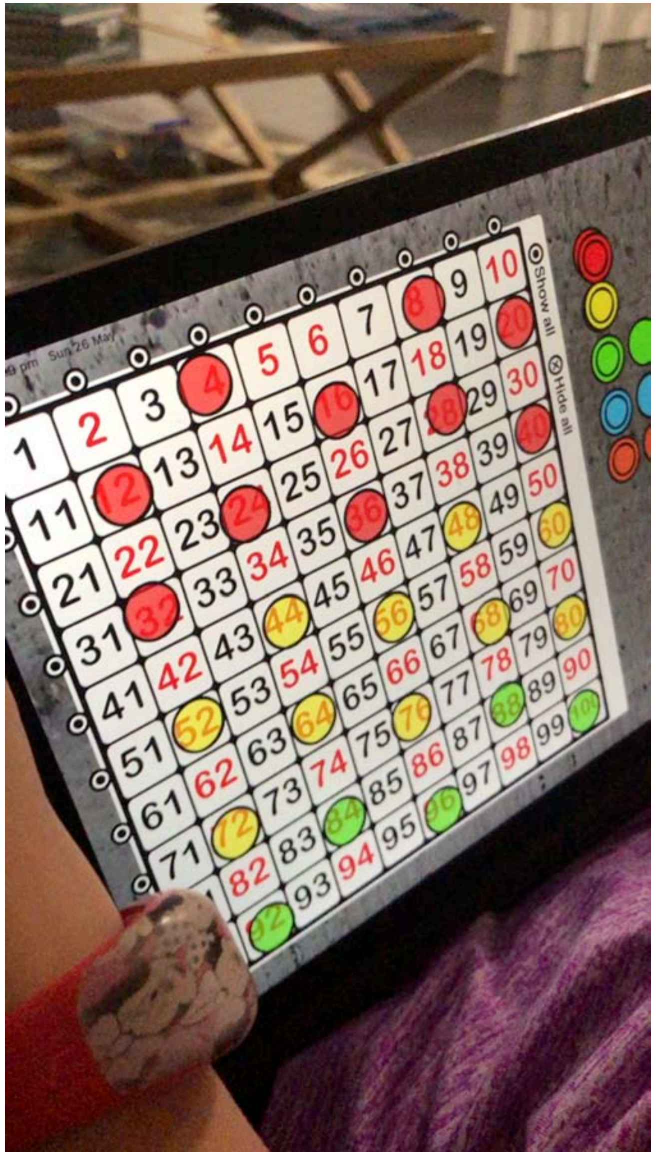
# Alpacas with Maracas



# How is the Technology Enhancing Learning?






# In Summary

- Cultural change is key.. Move away from can't to can
- When integrating digital technologies think about how you will develop all four of the proficiencies
- Do the students have opportunities for critical and higher order thinking?
- All decisions taken when integrating technologies in primary mathematics should be carefully examined.
- High quality Professional Learning is key to improvement in this area
- A primary teacher or leader should be able to easily answer, citing a range of evidence, why they have chosen to utilize technology in the manner chosen

# An Offer…

If your school seriously wants to pursue these ideas contact me…

- Dr Duncan Symons
  - duncan.Symons@unimelb.edu.au

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