ScratchMaths 2017 @ UON

Combining Coding and Maths

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Presentation Contents

- Why Teach Coding?
- Computational Literacy
- Coding to Learn Maths
- Combining Coding and Maths
  - Geometry
  - Percentages
- Summary

Why Teach Coding?

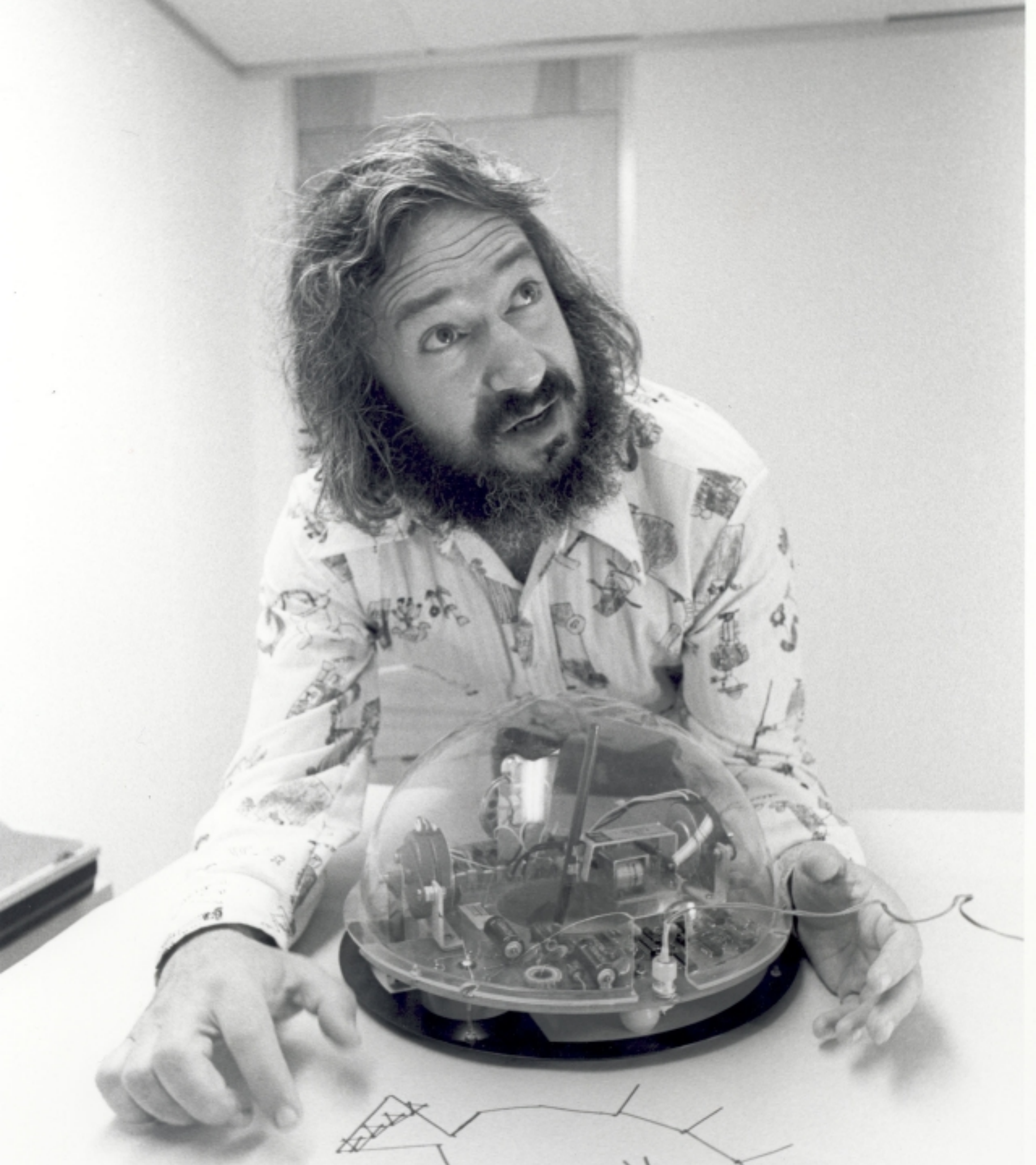
- There have been movements to teach Coding in K-12 and beyond
- Four main reasons for teaching Coding (or Computing) to everyone[1]:
  - Jobs
  - Computational Literacy
  - Helping People Understand the Digital World
  - Broadening Participation

[1] Guzdial, M. (2015). Learner-centered design of computing education: Research on computing for everyone. Synthesis Lectures on Human-Centered Informatics, 8(6), 1-165.

Computational Literacy

- Being computationally literate means to be able to:
  - Read and write code
  - Have an understanding of what a computer "can do and will do"[2]
- Involves both Coding and Computational Thinking
- Provides a new medium for expression, which could enhance learning in different subjects (e.g. Math and Science)

[2] https://computinged.wordpress.com/2012/05/24/defining-what-does-it-mean-to-understand-computing/



Coding and Learning Maths

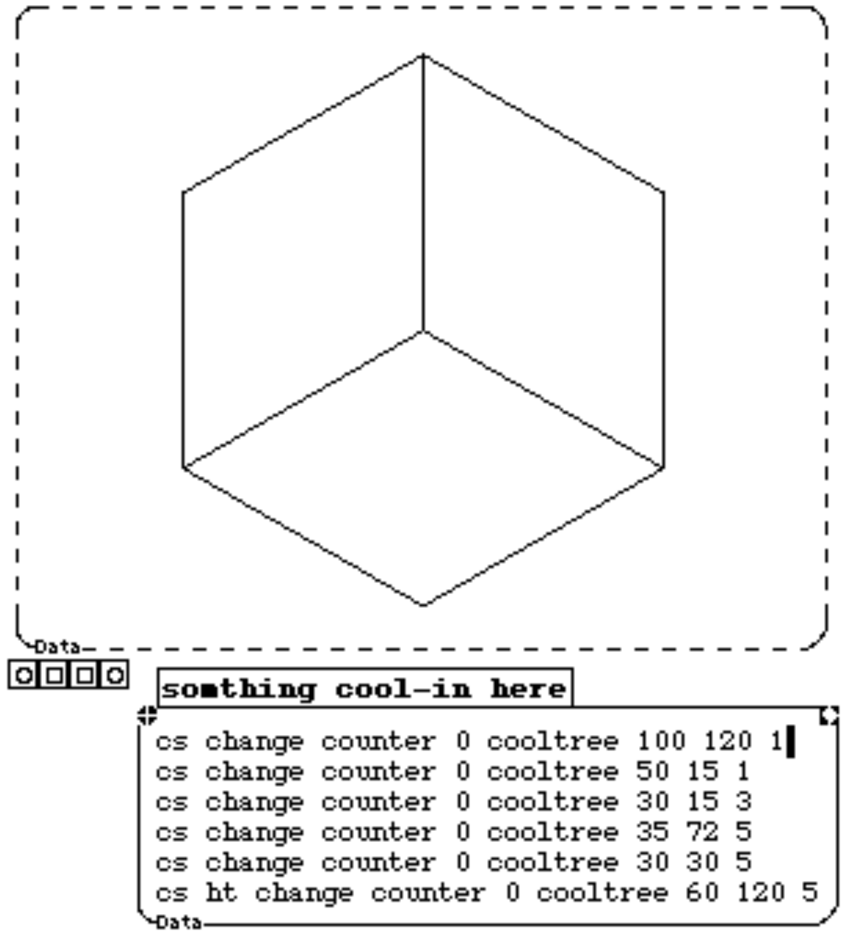
- **Seymour Papert:** *Mindstorms* (1980) and *The Children's Machine: Rethinking School In The Age Of The Computer* (1994)
- Led development of the Logo language, one of the first coding languages designed for educational purposes

Coding and Learning Maths

— **Andrea DiSessa:** *Turtle Geometry* (1981) and *Changing Minds* (2001)

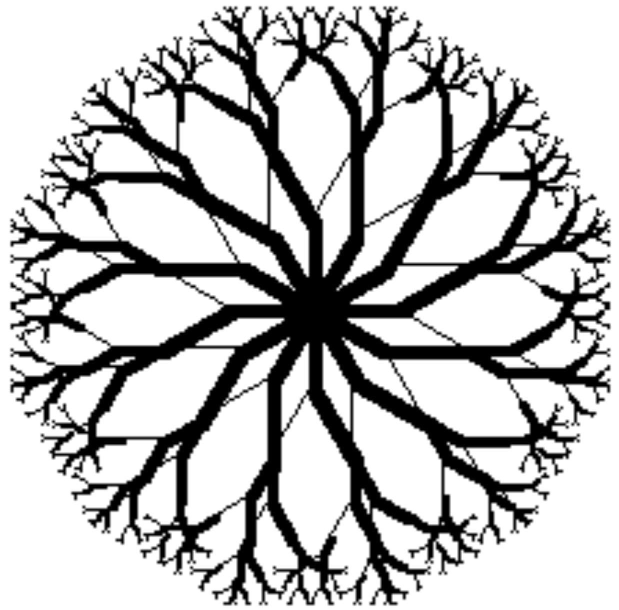
— Led the development of Boxer, which built on work by Papert on Logo

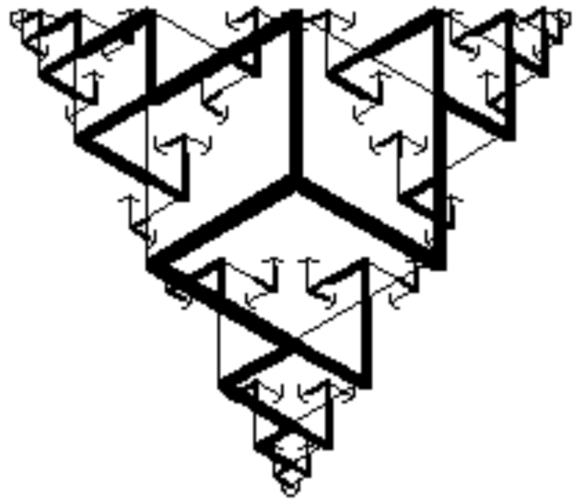
— In *Changing Minds*, wrote about *computational literacy* and constrasted this with literacy

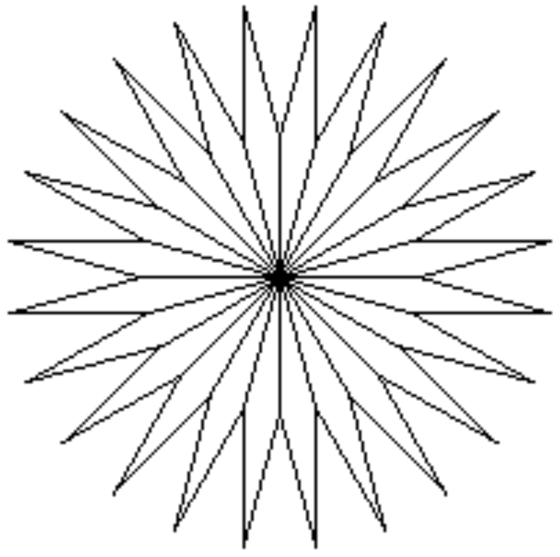


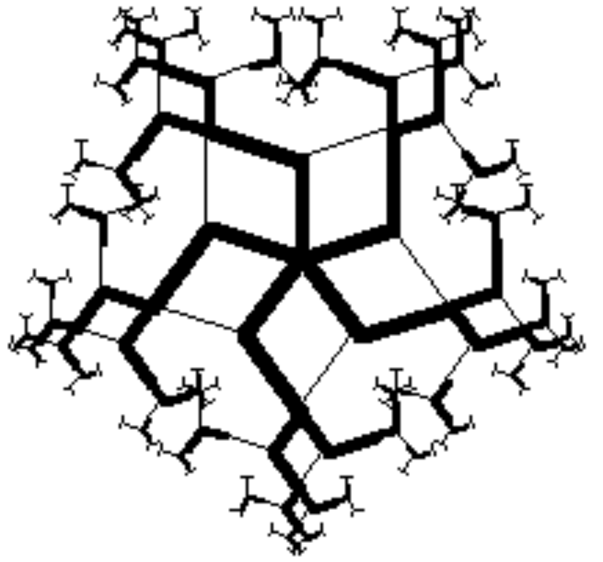
somthing cool-in here

```
cs change counter 0 cooltree 100 120 1
cs change counter 0 cooltree 50 15 1
cs change counter 0 cooltree 30 15 3
cs change counter 0 cooltree 35 72 5
cs change counter 0 cooltree 30 30 5
cs ht change counter 0 cooltree 60 120 5
```

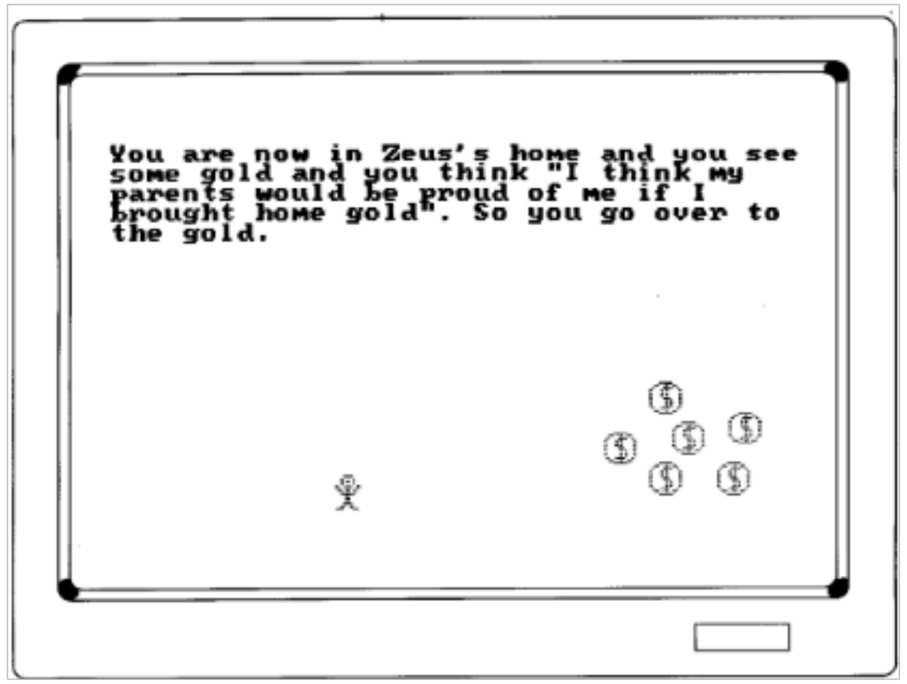




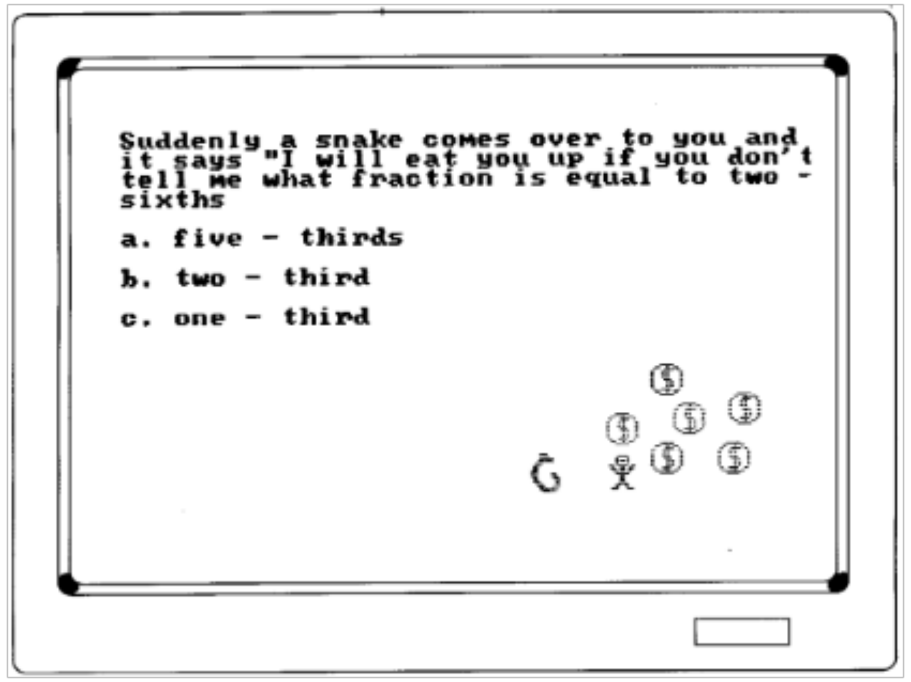




Coding and Learning Maths



You are now in Zeus's home and you see some gold and you think "I think my parents would be proud of me if I brought home gold". So you go over to the gold.



Suddenly a snake comes over to you and it says "I will eat you up if you don't tell me what fraction is equal to two - sixths

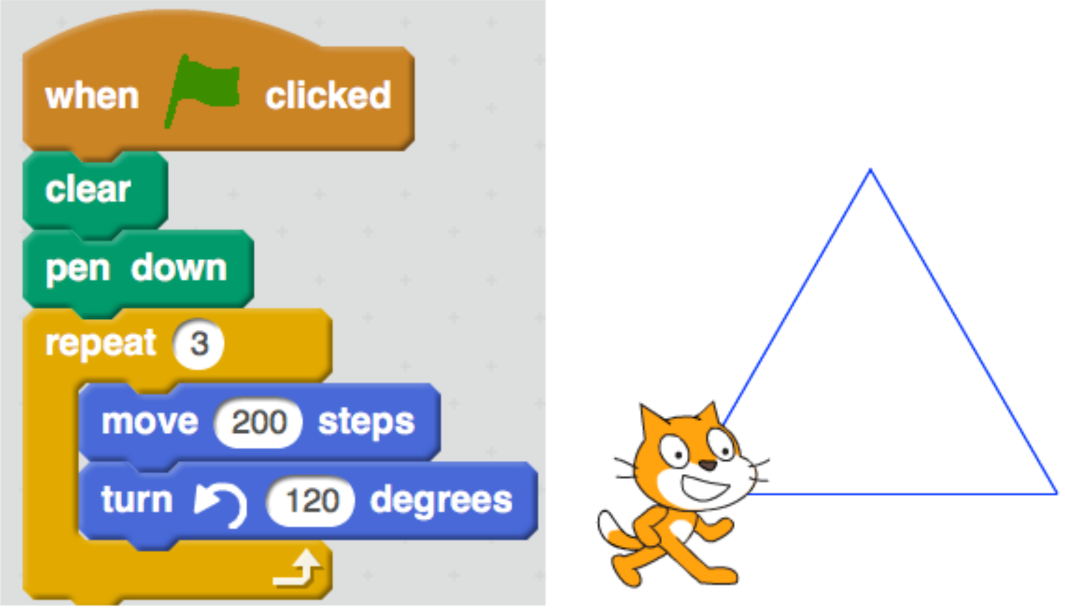
a. five - thirds

b. two - third

c. one - third

- **Yasmin Kafai:** *Connected Code: Why Children Need to Learn Programming* (2014) and *Connected Gaming: What Making Video Games Can Teach Us about Learning and Literacy* (2016)
- Worked with Papert on Logo and leads projects that research students learning from creating their own educational software
- Also researches how students learn coding through *making* things that aren't video games (e.g. e-textiles)

ScratchMaths



```
when [flag] clicked
clear
pen down
repeat 3
    move 200 steps
    turn ↺ 120 degrees
```

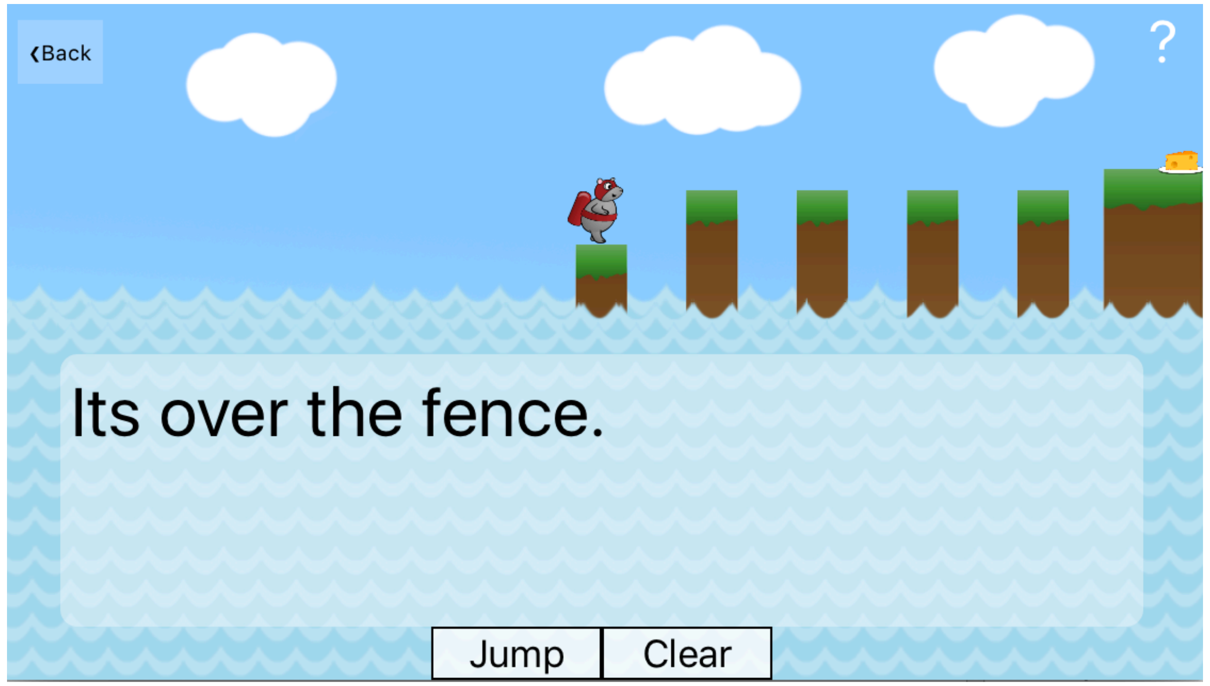
- Developed in England
- The project leaders in England, **Richard Noss** and **Celia Hoyles** (from University College London), have worked with all of the previously mentioned researchers
- Uses Scratch, which has been influenced by the design of languages/ environments like Logo and Boxer, as the Coding language

Combining Coding and Maths

- Some would argue that Maths and Coding are inseparable and that to be a good Coder you need a solid background in Maths
- There is definitely overlap and there are some areas of Maths (e.g. algebra, numbers and operations) that are essential to understanding Coding
- There are many examples of combining Maths and Coding in a variety of real-life projects
- I will give an example of a project that I was involved in

Combining Coding and Maths

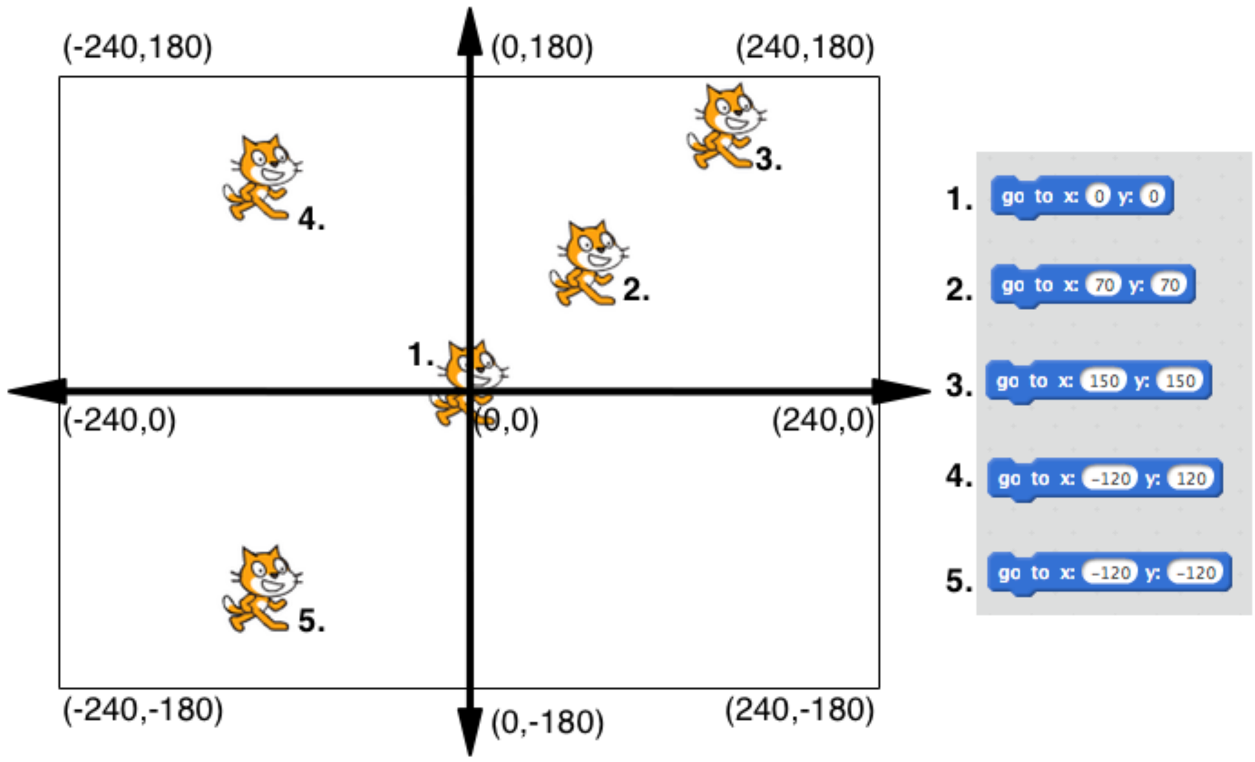
- Apostrophe Power: a mobile game that students can use as a tool for practicing their literacy skills
- I worked on the iOS (iPhone and iPad) version, someone else created the Android version



Its over the fence.

Geometry & Algebra

- In 2D games we have a canvas, which is a cartesian plane
- A lot of games (e.g. Super Mario or Space Invaders) involve moving sprites (images) around a canvas

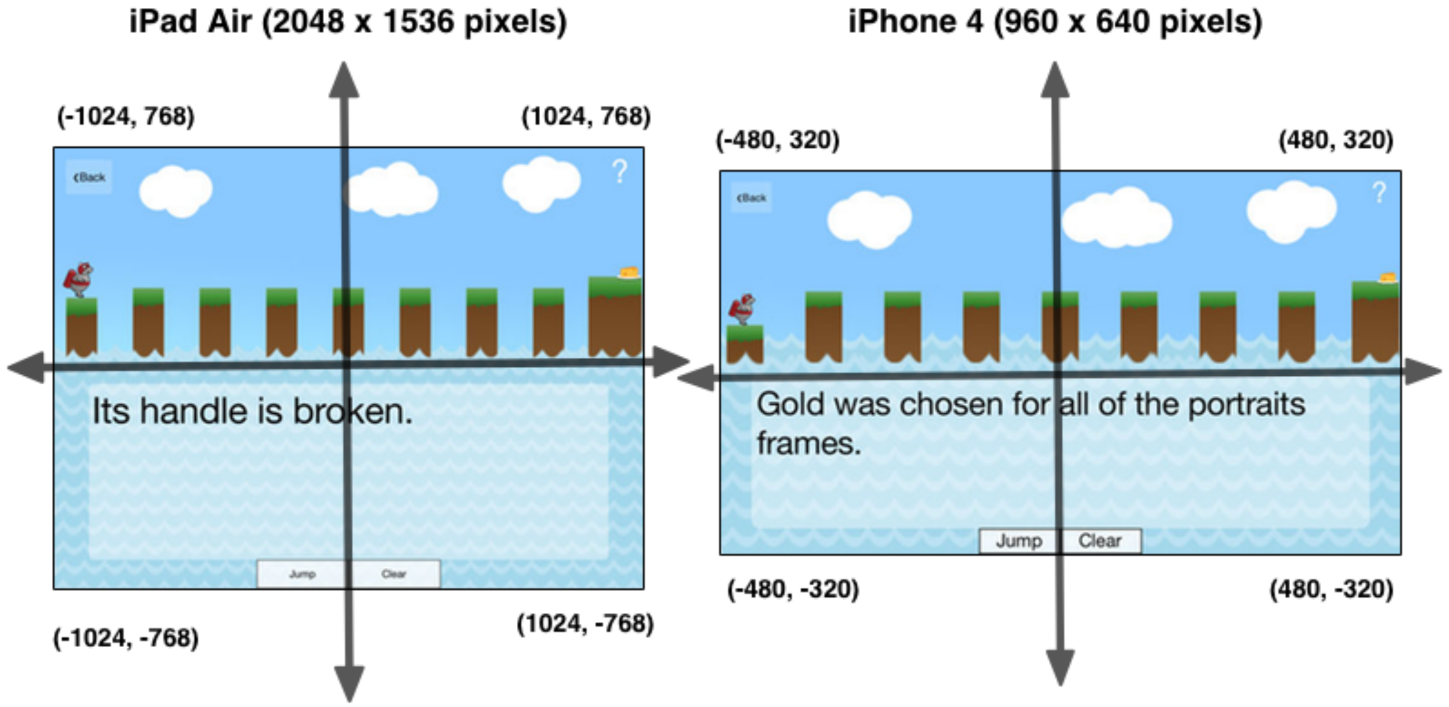


1. go to x: 0 y: 0
2. go to x: 70 y: 70
3. go to x: 150 y: 150
4. go to x: -120 y: 120
5. go to x: -120 y: -120

Geometry & Algebra

— It gets more complicated: iPads and iPhone (and all the different models) have different sized screens

— For example, what happens if we tell our hero to move to (-960, 400)?



Its handle is broken.

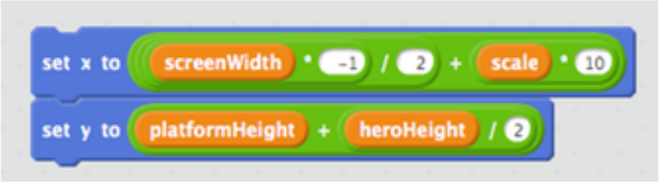
Gold was chosen for all of the portraits frames.

Geometry & Algebra

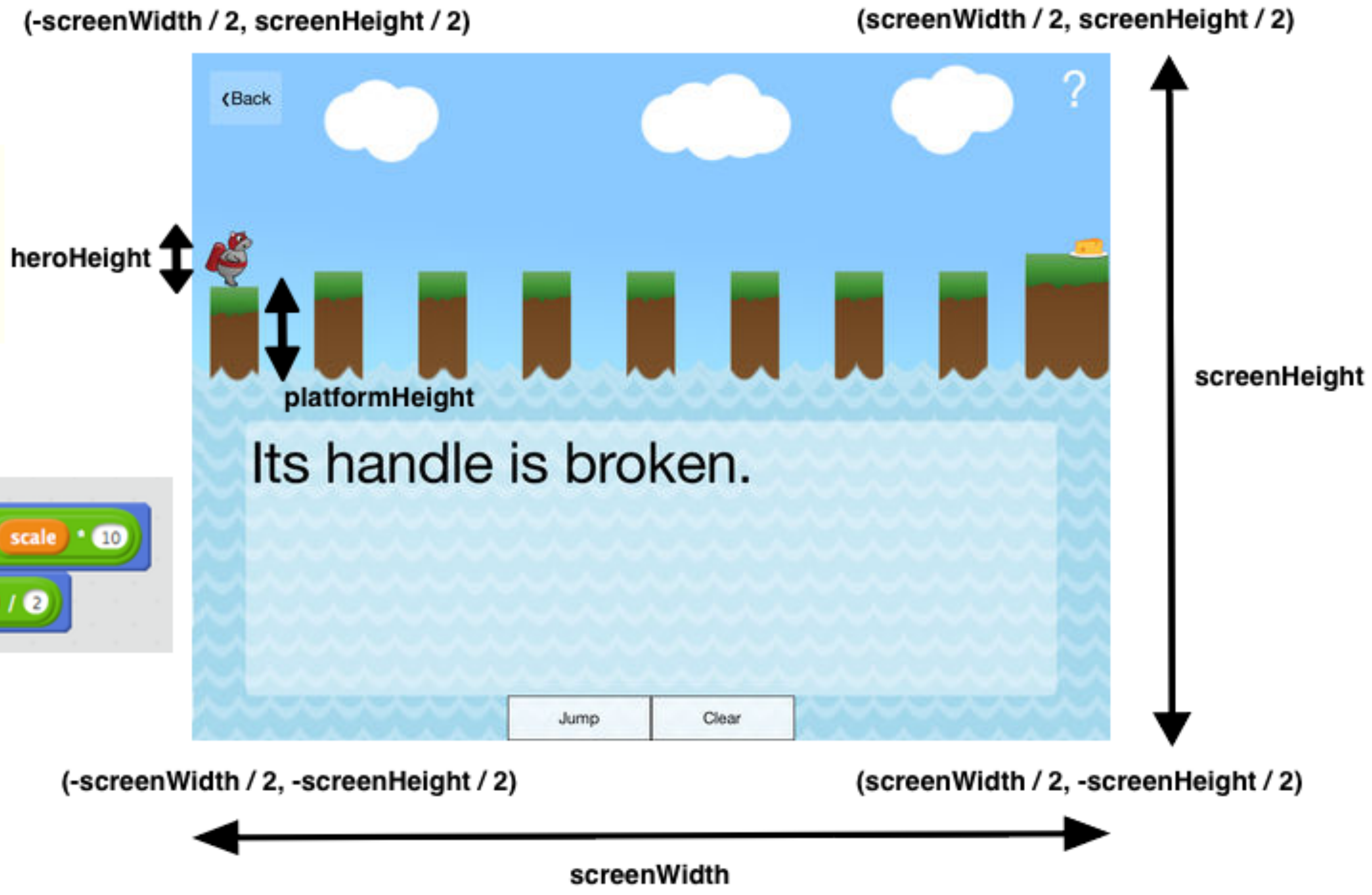
- We can solve this issue with Coding & Algebra

$$x = \left(\frac{-screenWidth}{2}\right) + (scale \times 10)$$

$$y = platformHeight + \left(\frac{heroHeight}{2}\right)$$



```
set x to (((screenWidth) * (-1)) / (2)) + ((scale) * (10))
set y to (platformHeight) + ((heroHeight) / (2))
```



(-screenWidth / 2, screenHeight / 2)
(screenWidth / 2, screenHeight / 2)
‹Back
?
heroHeight
platformHeight
screenHeight
Jump
Clear
(-screenWidth / 2, -screenHeight / 2)
(screenWidth / 2, -screenHeight / 2)
screenWidth

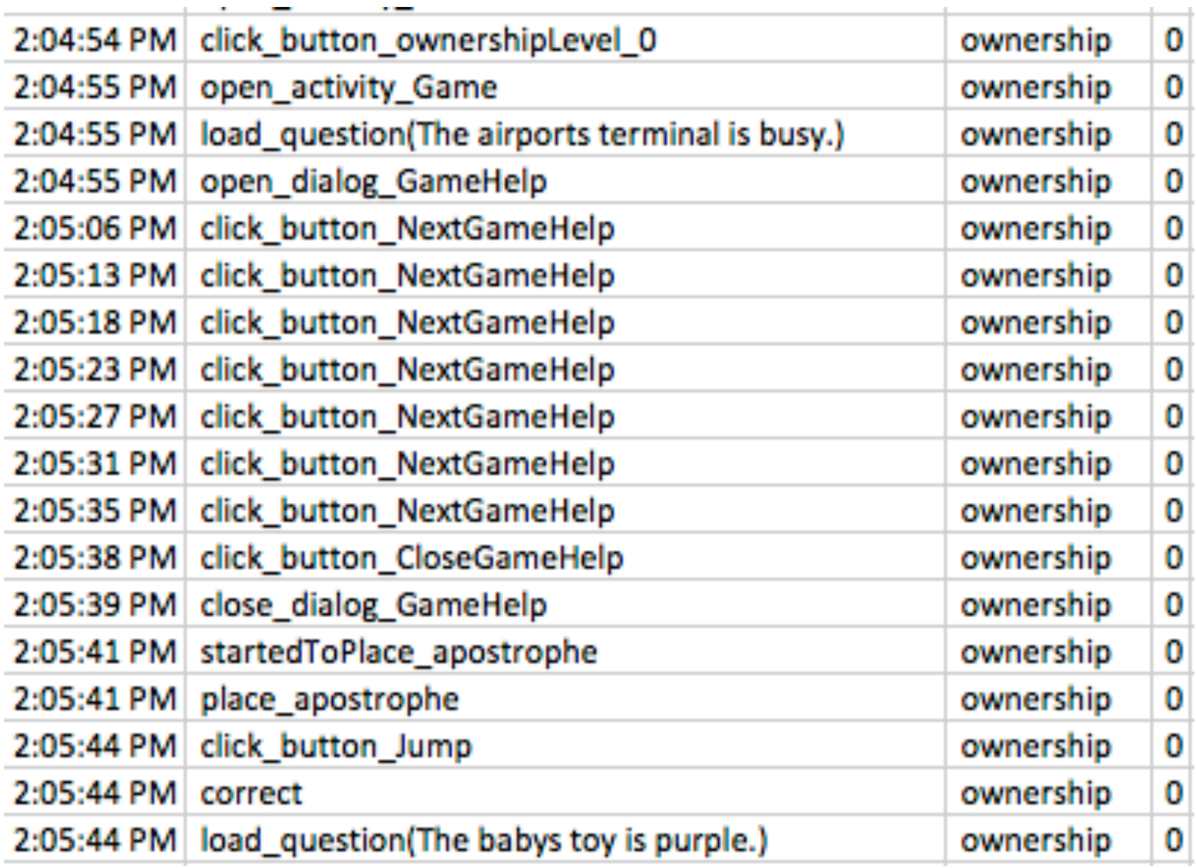
Its handle is broken.

Geometry & Algebra

- The geometry & algebra involved in this example are not much more complex than the concepts we will look at today and tomorrow
- Similar techniques are used in a variety of areas, e.g. Web Design for different devices - making websites look good on PCs, tablets and phones
- The maths for game design can get a lot more complicated, particularly if you are working in 3D games

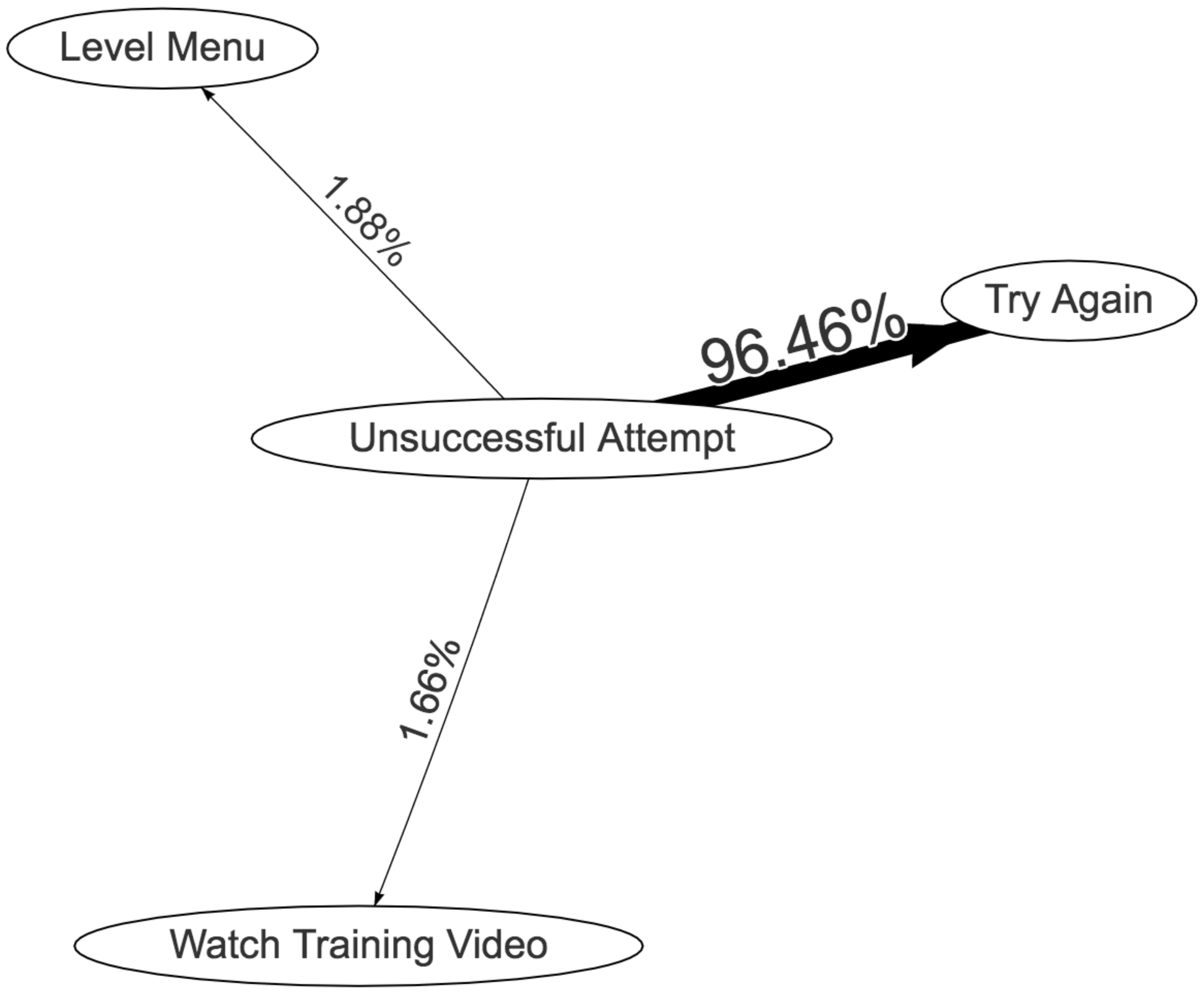
Percentages

- We also did some research following the game development, that involved testing the game with university students
- There was Code written in the Android version to log everything a player did
- From 40 minute sessions, we would get a file with 1000s of these events
- What did students do after answering a question unsuccessfully? Watch a video? Try again? Quit the level?



2:04:54 PM	click_button_ownershipLevel_0	ownership	0
2:04:55 PM	open_activity_Game	ownership	0
2:04:55 PM	load_question(The airports terminal is busy.)	ownership	0
2:04:55 PM	open_dialog_GameHelp	ownership	0
2:05:06 PM	click_button_NextGameHelp	ownership	0
2:05:13 PM	click_button_NextGameHelp	ownership	0
2:05:18 PM	click_button_NextGameHelp	ownership	0
2:05:23 PM	click_button_NextGameHelp	ownership	0
2:05:27 PM	click_button_NextGameHelp	ownership	0
2:05:31 PM	click_button_NextGameHelp	ownership	0
2:05:35 PM	click_button_NextGameHelp	ownership	0
2:05:38 PM	click_button_CloseGameHelp	ownership	0
2:05:39 PM	close_dialog_GameHelp	ownership	0
2:05:41 PM	startedToPlace_apostrophe	ownership	0
2:05:41 PM	place_apostrophe	ownership	0
2:05:44 PM	click_button_Jump	ownership	0
2:05:44 PM	correct	ownership	0
2:05:44 PM	load_question(The babys toy is purple.)	ownership	0

Percentages



— Code was written to count up the relevant events and visualise how often players made certain choices

$$\left(\frac{\text{Times the player chose to try again}}{\text{total number of events}}\right) \times 100$$

— Similar techniques are used in a variety of areas, particularly those where people need to make sense of large amounts of data

Summary

- There are more than a few reasons for teaching Coding in primary school
- Our focus is on teaching Coding for *Computational Literacy*
- Researchers and educators have found that Coding can enhance the learning of other subjects, such as Maths
- An understanding of Coding, Maths and how to combine them can help students approach problems in a variety of areas