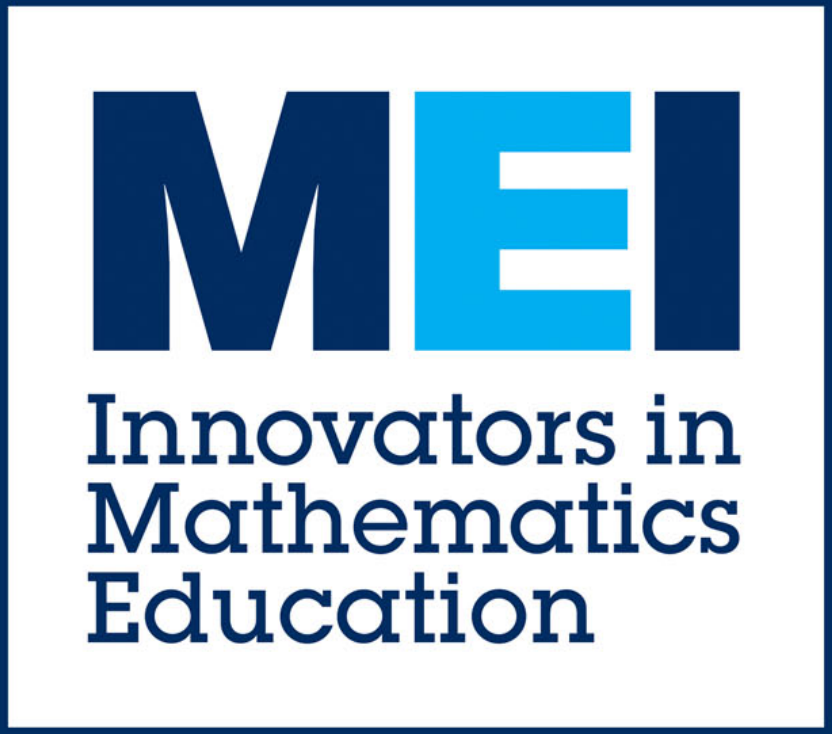


Mathematics in Education and Industry

50 years at the forefront of Mathematics Education

The challenges of creating online maths games to encourage independent learning

Richard Lissaman and Trevor Hawkes

This session

- Background – students' expectations of digital content; why might games be good medium for learning maths?
- What is already out there for mathematics? What are the challenges to producing good maths games?
- Bemazed – a maths game developed by the Sigma Network and MEI.

Popularity of gaming (2008)

- 53% of American adults aged 18 or over play video games (Men 55%, Women 50%)
- 97% of teenagers play video games
- Global gaming sales over $60 billion per year

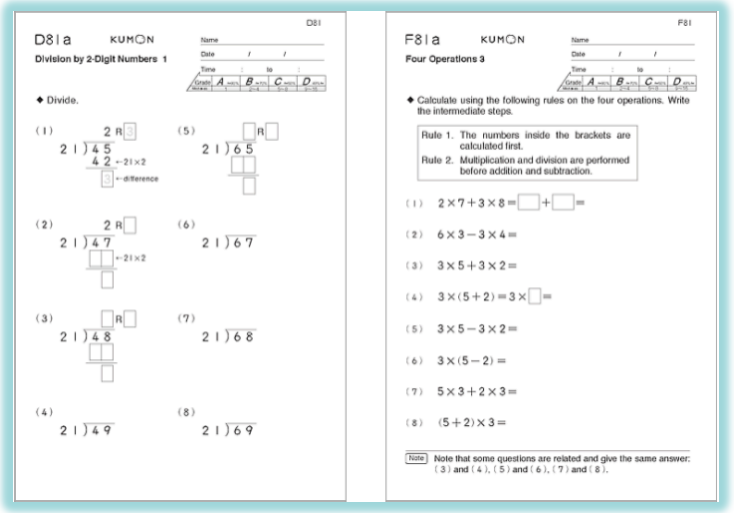
Pew Research Centre (2008)

Popularity of gaming

Also 2008:

- Grand Theft Auto IV grossed $310 million on its first day of release
- Harry Potter and the Deathly Hallow $220 million on day of release
- Spider Man 3 took $60 million

Many students are alienated by an approach based on traditional learning materials



D8 I a KUMON

Division by 2-Digit Numbers 1

◆ Divide.

(1) 2 R 3
21)45
42 ←21×2
3 ←difference

(2) 2 R □
21)47
□ ←21×2
□

(3) □ R □
21)48
□□

(4) 21)49

(5) □ R □
21)65
□□

(6) 21)67

(7) 21)68

(8) 21)69

F8 I a KUMON

Four Operations 3

◆ Calculate using the following rules on the four operations. Write the intermediate steps.

Rule 1. The numbers inside the brackets are calculated first.
Rule 2. Multiplication and division are performed before addition and subtraction.

(1) 2×7+3×8=□+□=
(2) 6×3−3×4=
(3) 3×5+3×2=
(4) 3×(5+2)=3×□=
(5) 3×5−3×2=
(6) 3×(5−2)=
(7) 5×3+2×3=
(8) (5+2)×3=

Note Note that some questions are related and give the same answer: (3) and (4), (5) and (6), (7) and (8).

≠

Teaching and learning materials should embrace where students come from and what is out there that impacts their cultural life

The case for learning maths by playing games

- Association with a feeling of play; non-intimidating competition which is fun and familiar
- Games are immersive, and can deal with issues around relevance
- Learning through trying things is a good plan - a feeling of "I can figure it out"
- Allows a dynamic representation of mathematics
- Learning can be very carefully staged and adaptive.

Learning and Teaching Scotland 2008

- Initial test took by 600 students in 32 Scottish schools
- Trial group used, under structured supervision, Dr Kawashima's Brain Training
- Control group continued their studies normally
- Those who used the game showed 50% greater improvement than those who hadn't
- Increases were most significant in students at the lower end of the ability spectrum

What is out there already?

Vast majority of maths games are one of the following types

- 'Maths racers' e.g. Brain Training
- 'Puzzle adventures' e.g. Professor Layton and L
- 'Maths dressed as a game'

What would be the qualities of a good maths games'?

- Student can enter the game with reasonable pre-requisite knowledge and can explore and learn a new mathematical idea in a way that
  - is fun and not-intimidating
    - is challenging (requires thought)
    - results in real learning
    - results in confidence

Building the game around the mathematical concept

- Keith Devlin

What are the main challenges

- How to allow the student to discover the mathematical concept for themselves?
- How to embed the concept in the game mechanic?
- How do players input their answers?
- How fast should you expect the player to play?
- **All these need to be balanced against the needs of the application as a game.**

A Sigma/MEI App

BEMAZED

Aims

- mathematical concepts are learnt in a totally unique, hopefully fun, way
- some problem-solving skills are developed
- awareness of Sigma and MEI is raised

Game concept

- Player controls a block which has a number on it
- That number is changed when the player moves through other blocks which apply a mathematical operation
- Some blocks are ‘conditional’ - they can only be passed when the player’s number meets a specified condition.
- Aim is to apply mathematical operations in the correct order to make progress

Have a go

- Start with the Arithmetic levels
- We're very interested in your comments and feedback, we expect the app to be released very soon!

Strength of concept

As a game:

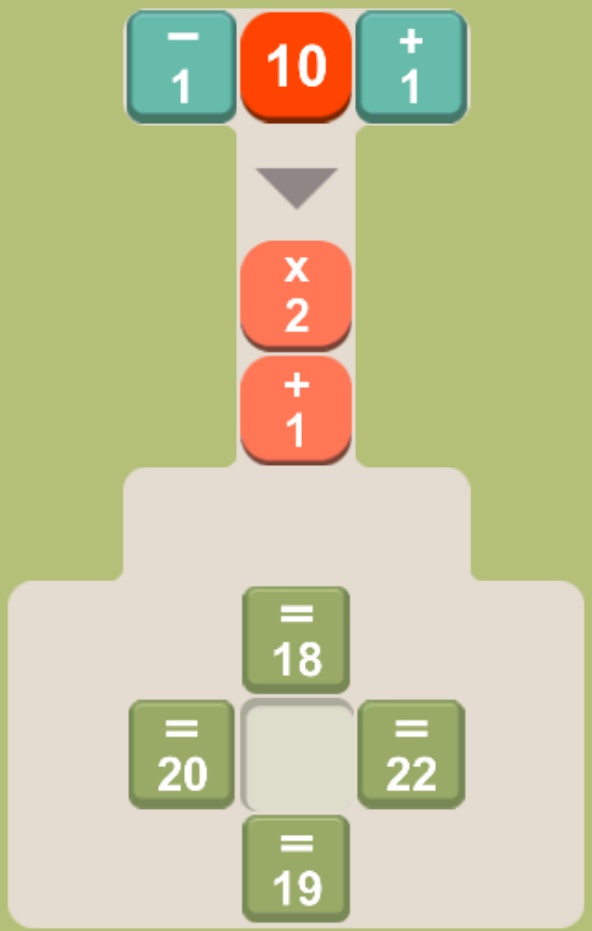
- Very easy to pick up the rules and objectives
- Very strong visual representation of 'puzzles'
- Very simple controls

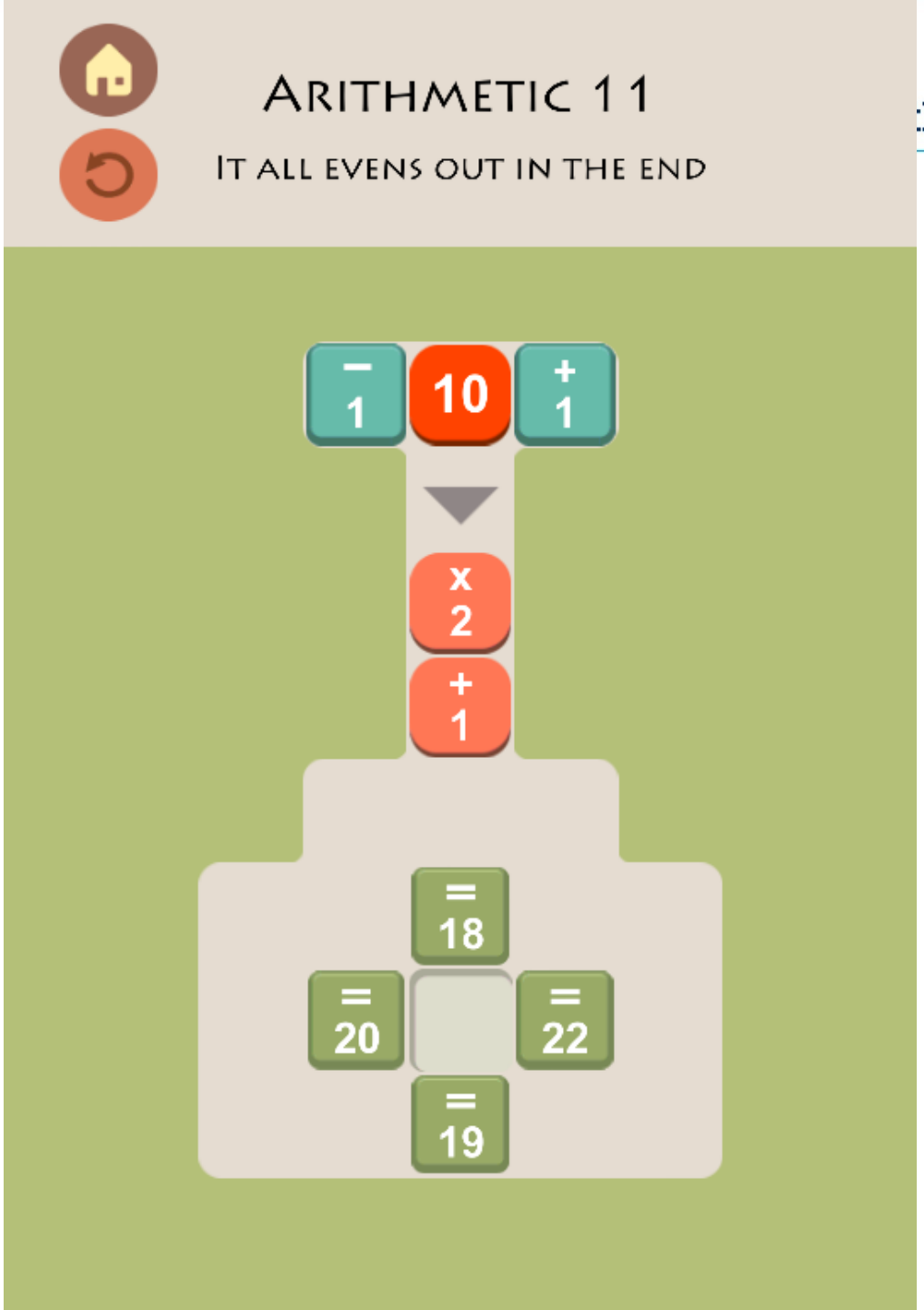
As a maths resource:

- Natural, dynamic representation of the notion of operation/function
- Introduces mathematical ideas gradually
- Encourages logical thinking, development of problem-solving skills

Arithmetic 11

It all evens out in the end





Compare this to:

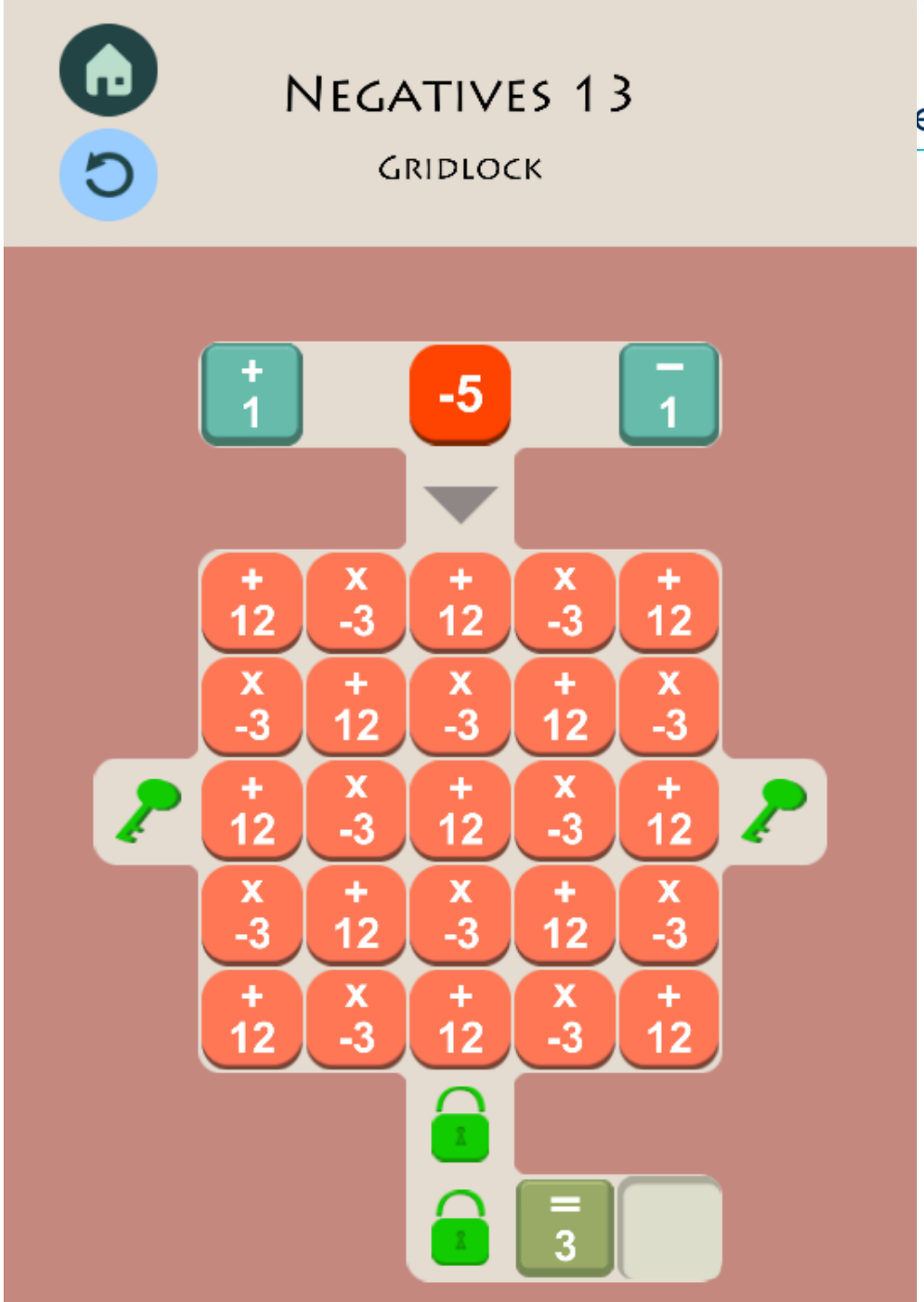
How do you define odds and evens?

2n + 1 is odd for any integer

An integer n is said to be even if there exists an integer m such that…?

Negatives 13

Gridlock



Compare this to:

Find a fixed point of the function $f(x) = -3(x + 12)$

Inequalities 4

Upon reflection

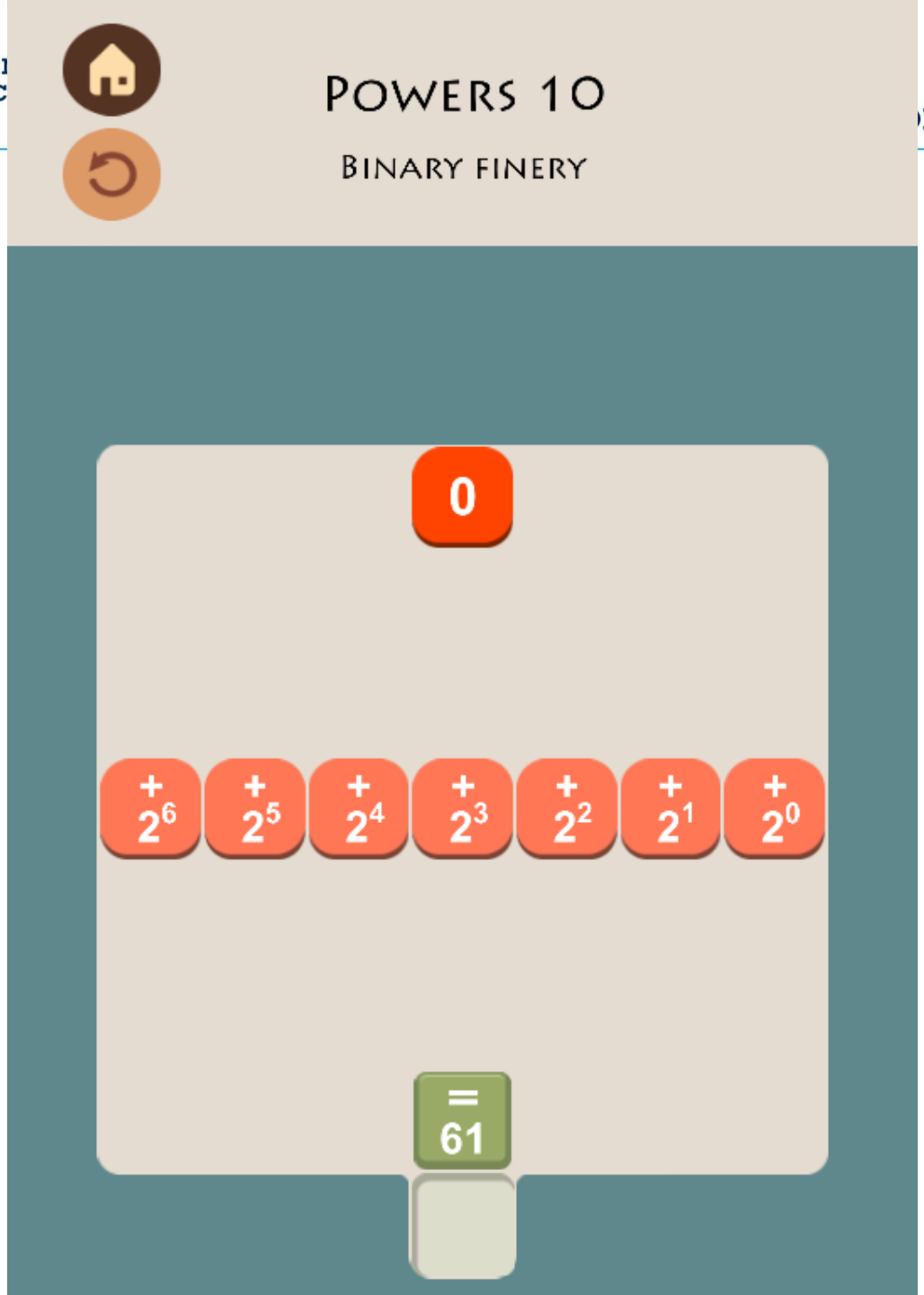
Compare this to:

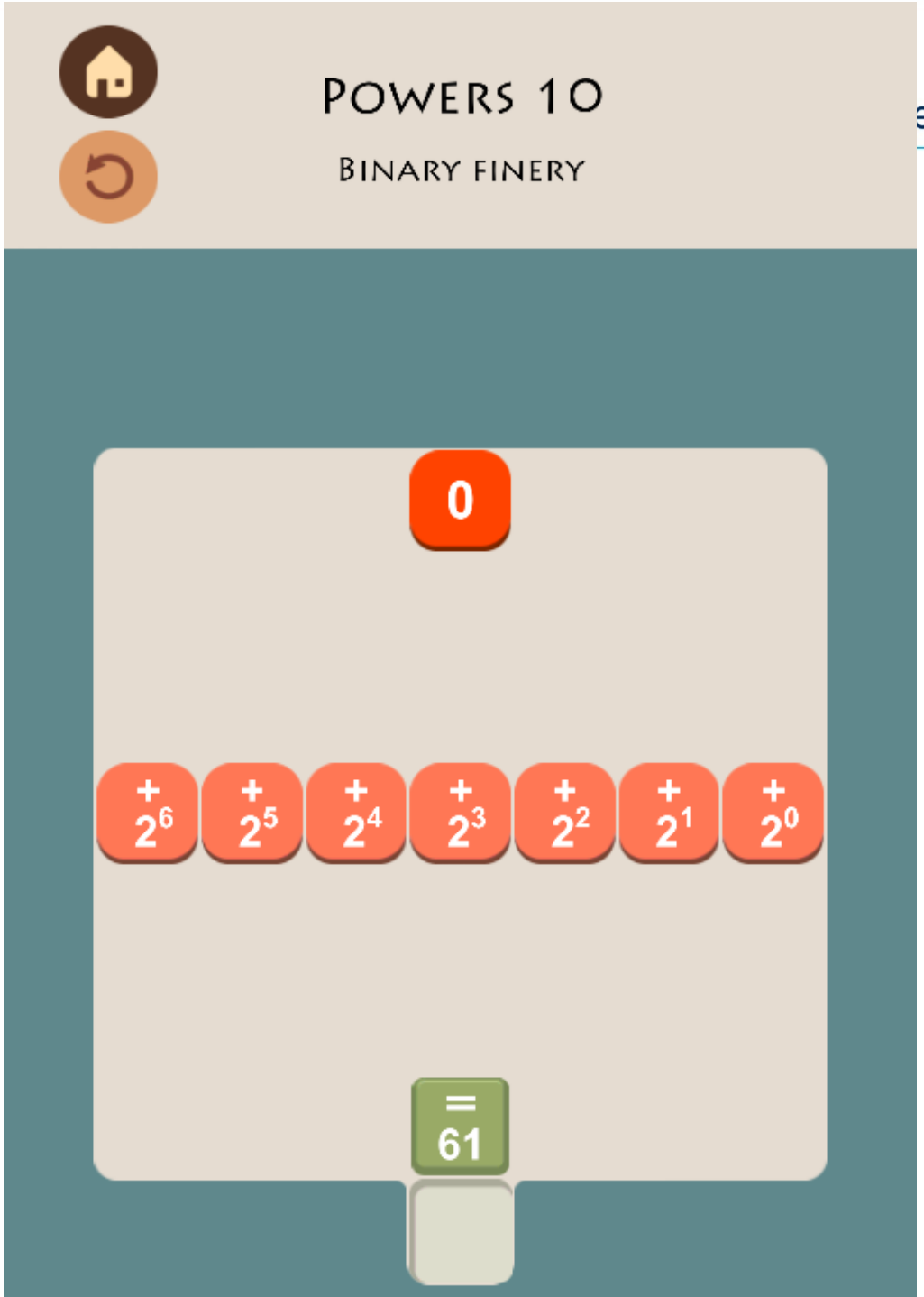
If $x > y$ are real numbers then $-x < -y$?

Give examples. Try to explain why this is true.

Powers 10

Binary finery





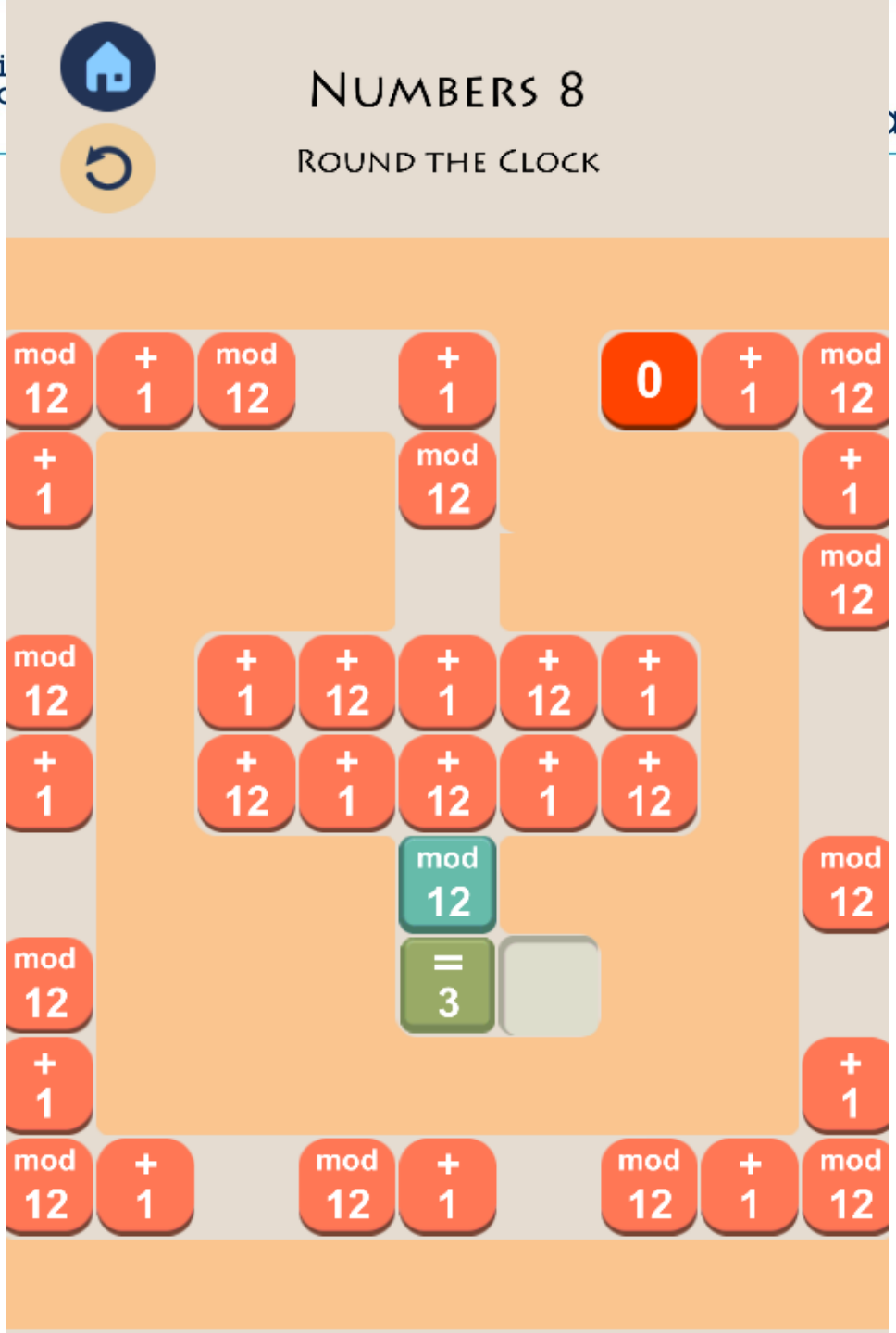
Compare this to:

Every integer has a unique representation in binary.

Give examples. Given an integer how do you find its unique representation?

Numbers 8

Round the Clock



What next?

- Now try some other levels.

What next?

- Is anyone willing to try this out the next time they are asked to explain indices, inequalities, the modulus function, logarithms or complex numbers?
- Is anyone willing to try this out with general students visiting maths support centres?