CAMBRIDGE
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MINECRAFT EDUCATION

Teacher support materials

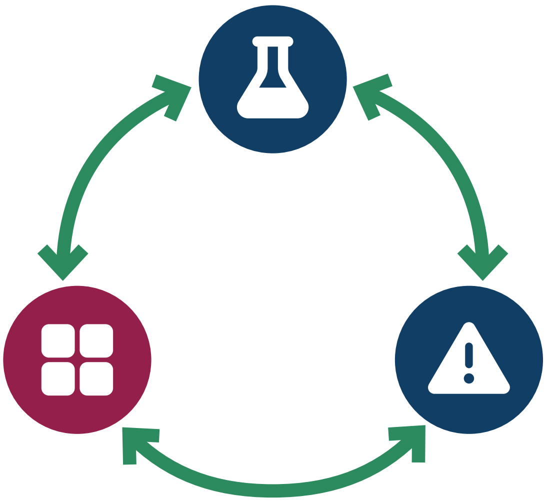
for Window Wiz

CAMBRIDGE Mathematics

Connections to other Ratio Riddles activities

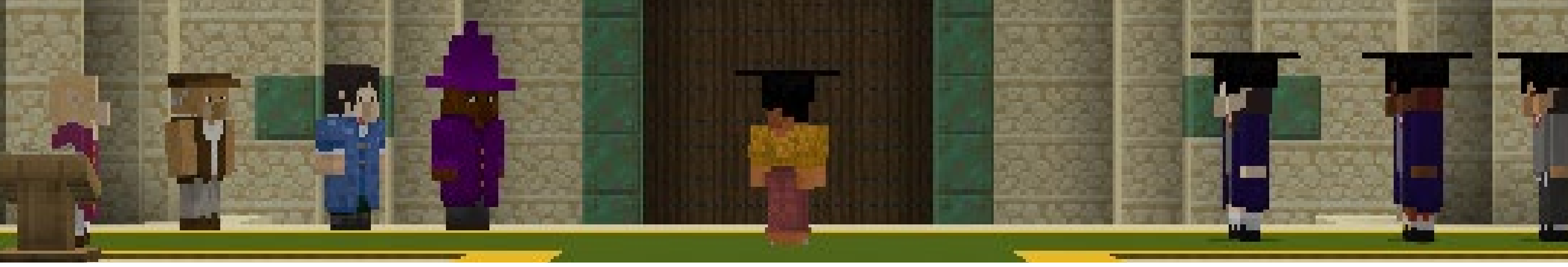
This is one of three activities in Ratio Riddles. These activities complement one another and provide a useful set of experiences that can help students build strong and flexible foundations in proportional reasoning:

Potion Commotion
(ratio)



Window Wiz
(scaling)

Keep Off the Grass!
(fractions as magnitudes)



Game activity and learning

Thinking of fractions as numbers between 0 and 1 is just part of the story. Many numbers greater than 1 can also be written as fractions. This activity focuses on increasing students' flexibility with fractions by using them as way of writing quantities greater than 1, where one number (the numerator) is divided by another (the denominator) to produce a number they need in the game. For example, $\frac{2}{1}$ expresses the number 2, and $\frac{10}{5}$ also expresses the number 2.

Challenge

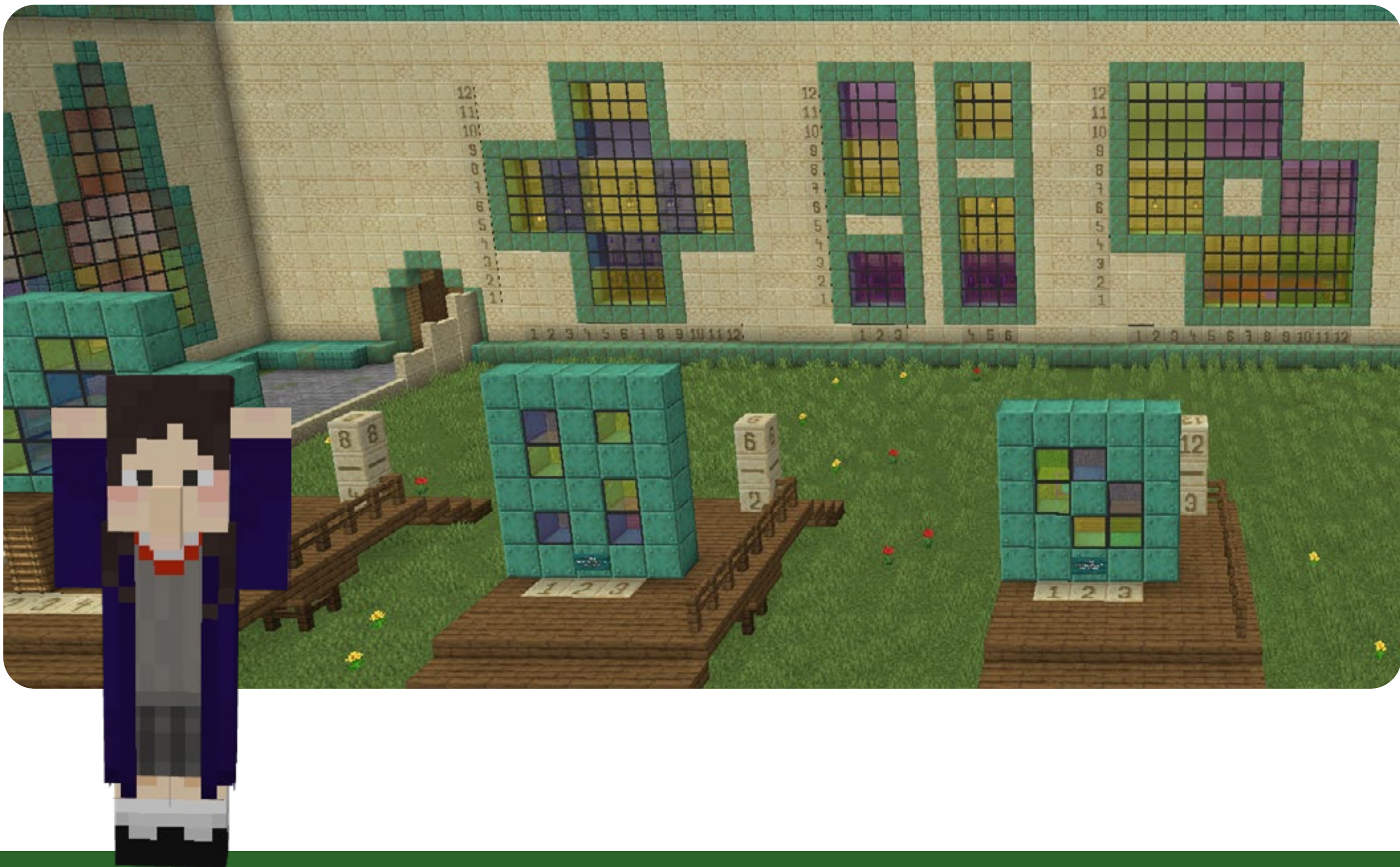
In this game, fractions are used to express scale factors. Although expressed as fractions, the scale factors are equivalent to whole numbers. These scale factors are used to 'magically' scale up small windows, which the player decorates, into huge ones in the walls of a building. What scale factor will scale up the window design to the full size of the window without creating far more window than the building can handle?

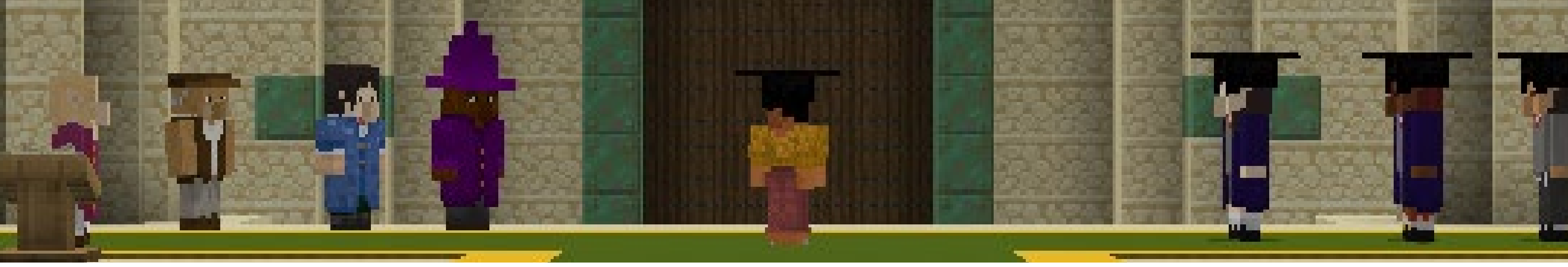
Connections

This activity connects ideas of static proportionality, fractions greater than 1, and equivalent fractions. Students can see the physical effects of applying static scale factors to two-dimensional window shapes in the game, which they control by manipulating fractions in a variety of forms to apply scale factors equivalent to either 1, 2, 3 or 4.

Scaffolding

At first, students try the process with the simplest scale factor, 1, expressed as $\frac{1}{1}$. Then they scale up windows using numerators greater than 1; e.g., $\frac{2}{1}$. Finally, they create whole-number-equivalent scale factors using denominators greater than 1, with numerators which are whole-number multiples of the denominator.

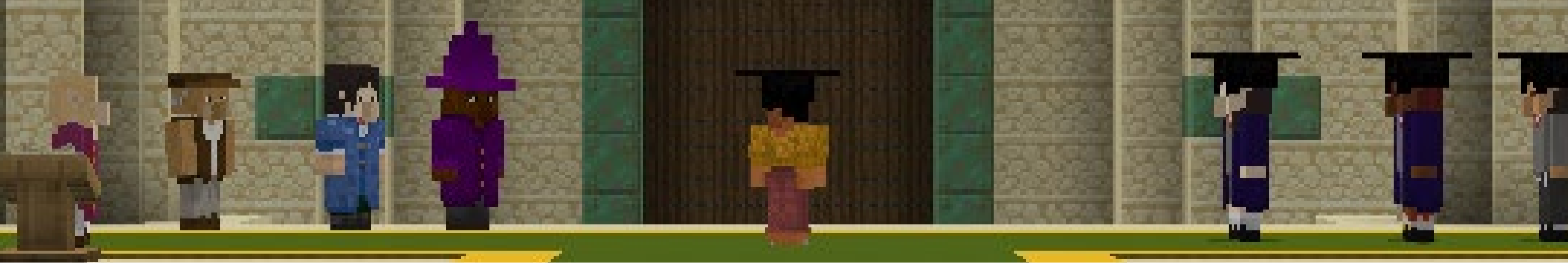


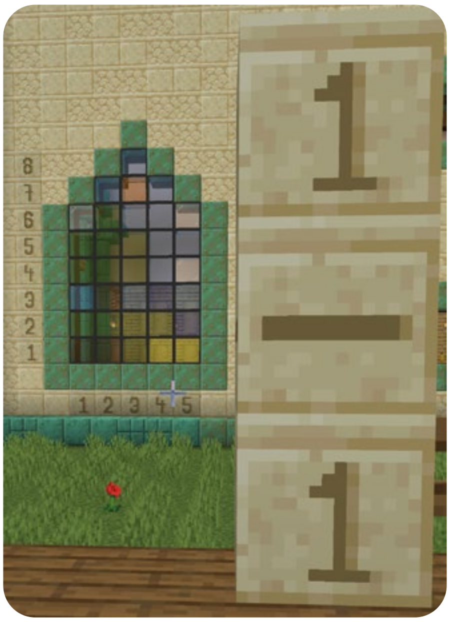


Gameplay guide

After starting the activity with the Dean of Students, the player follows the Guild Leader to a window building area. A starting tutorial lets players magically create a window based on a scale model with the scale set to ¹⁄₁. Then the players are asked to create model designs and their respective scale factors to complete two large windows, keeping the scale factor fraction denominator at 1. When they do so successfully, they are challenged to create model designs and scale factors for three large windows with elaborate shapes, with a scale factor fraction denominator other than 1.

Each time players hit the scaling orb with their wands, they'll get feedback from the Guild Leader about their scale factor choices. If the window is too big or too small they can see this, and the Guild Leader will react and tell them if they were successful, or if not, what happened.





1/1 equivalent to 1

2/1 equivalent to 2

4/1 equivalent to 4

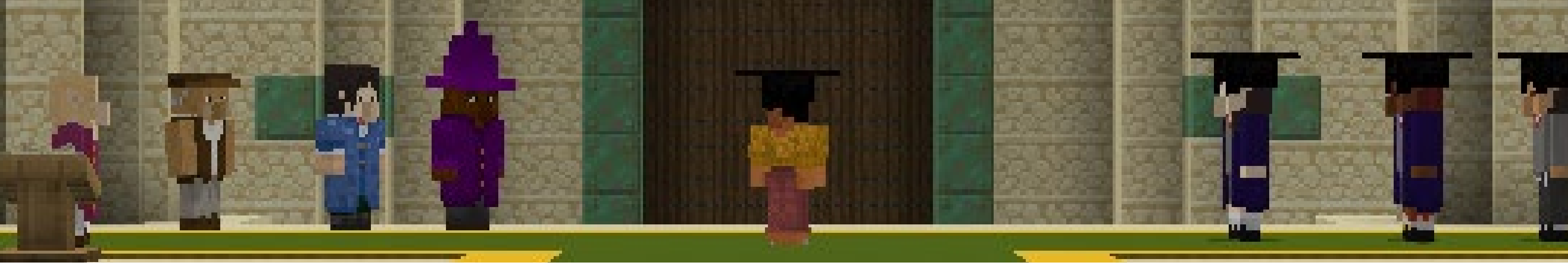
8/4 equivalent to 2

6/2 equivalent to 3

12/3 equivalent to 4

Note: In this activity the denominators cannot be changed so there is only one correct answer per window.

After completing three windows, the Guild Leader gives players the option to proceed to Junior Graduation or build more windows. After players have built all six windows, they can proceed to Senior Graduation. Once they graduate from the activity, the Dean of Students gives them a portfolio and a camera; they can take pictures anywhere in the activity and export their portfolio as a keepsake if they wish.



Concept focus

This learning activity offers two conceptual focus areas of mathematics for exploration: Viewing fractions as a division operation and scaling up with whole number scale factors. Examples are provided below of the ideas in each area which students may encounter whilst playing the game.

Viewing fractions as a division operation

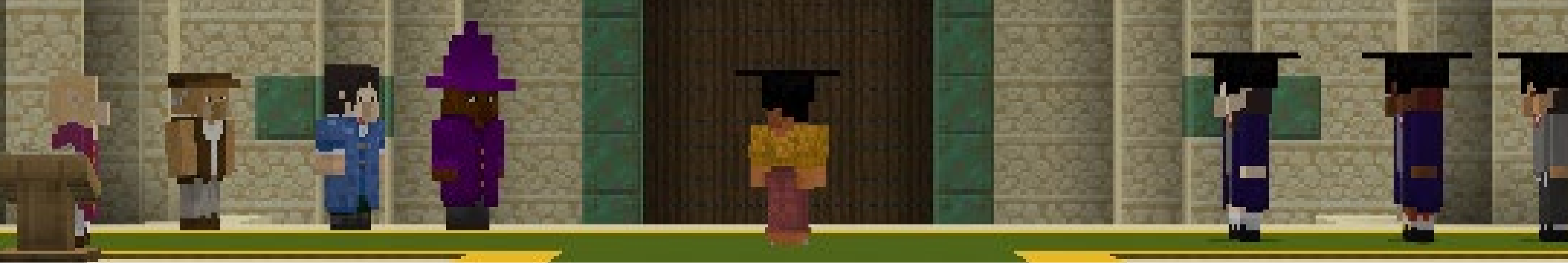
- Knowing that a fraction has multiple meanings (for example, a proportion, an operation, an equal share) and may be represented in a variety of ways (for example, a point on a number line, a piece of a chocolate bar) can be helpful both for solving problems and for making meaningful connections between types of operation, rational numbers and, later, algebraic expressions.
- Working with fractions as quantities greater than 1 helps students to move beyond a part-whole concept of fractions towards working flexibly with proportion in a variety of forms (ratio, fraction, decimal and percentage) and helps prepare them to work with rational numbers; for example, $\frac{27}{4}$.

Scaling up with whole number scale factors

- Working with length scale factors gives students the opportunity to explore proportionality in fraction-focused contexts before encountering it in more complicated contexts like linear functions and rates.
- Many scaling activities focus on scaling down with scale factors less than 1; scaling up can balance out students' experiences and support flexibility with applications of scaling and proportions greater than 1.
- An example of a real-world application of scaling up is in architecture, where scale models are often produced first to guide production of the full-sized building. Other examples include clothing patterns, where small drawings are scaled up to full-sized fabric pieces, and maps, where a small distance represents a proportionally larger one. In the real world, scale factors for scaling up may not always be whole numbers, but small representations are often designed so that people can use relatively simple scale factors to work with them.

Key mathematical terms

- **Width:** The distance from one side of a thing to the other.
- **Height:** The distance from the bottom to the top of something.
- **Scale up:** To increase the size or quantity of something by a constant amount called a scale factor.
- **Scale factor:** The ratio of corresponding side lengths of two shapes. For example, if you use a scale factor of two, you can make a thing twice as big as the original. If the scale factor is $\frac{1}{2}$ you can make the thing half its original size.
- **Scaling:** Changing the size of something proportionally, so that its shape remains the same.
- **Numerator:** The numerator is the name for the top number in a fraction. It is how many parts you have.
- **Denominator:** The denominator is the name for the bottom number in a fraction. It is how many total equal parts the whole is divided into.
- **Equivalent:** Equivalent means two things are the same in numerical value, even if they look different. For example, $\frac{1}{2}$ and $\frac{2}{4}$ are equivalent fractions because they both represent the same amount on a number line.
- **Whole number:** Any positive number you might use to count things, and zero.



Observe gameplay and prompt thinking

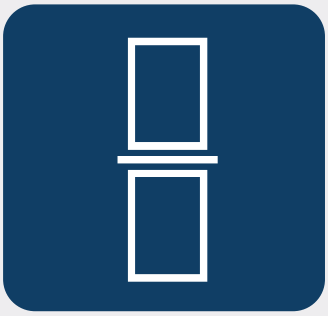
- You can ask students to describe how they're coming up with their scale factors. Are they comparing the proportion of lengths, or heights, or focusing on special parts of each window?
- If students seem to be hitting the scaling orb with their wand a lot, they may just be guessing. You could ask them to do one of the activities described below.

After/before/in between playing, you might like to:

- Have the students design their own stained glass window shapes on graph paper and scale them up. The windows can be hung around the classroom.
  - For a more advanced discussion, ask students to count squares to calculate the area of a window they have designed before and after scaling up length and width. How is area scaling different from length and width scaling?
- Try one of the collaborative or competitive versions of this dice game about creating fractions and placing them on number lines. Each pair of students will need two 0–9 dice and a piece of paper. **Note: Expect questions and discussions to be generated around zero being a numerator or denominator.**

Version 1 (collaborative)

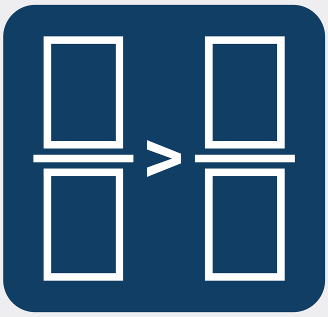
Students take turns to draw an "empty" fraction like the image, roll the dice and fill in the numbers to create a fraction. For example, if a 2 and a 6 were rolled, the fraction made could be $\frac{2}{6}$, or $\frac{6}{2}$. Their partner should now create a fraction where the numerator and denominator are reversed, and they can compare the two fractions. Which is larger? How do they know? Can either be simplified? Ask students to place their fractions on a number line which they draw themselves and notice whether they add any other numbers as benchmarks. Observations gathered from different pairs around the classroom could form the basis of a whole class discussion to explore what has come up for students.

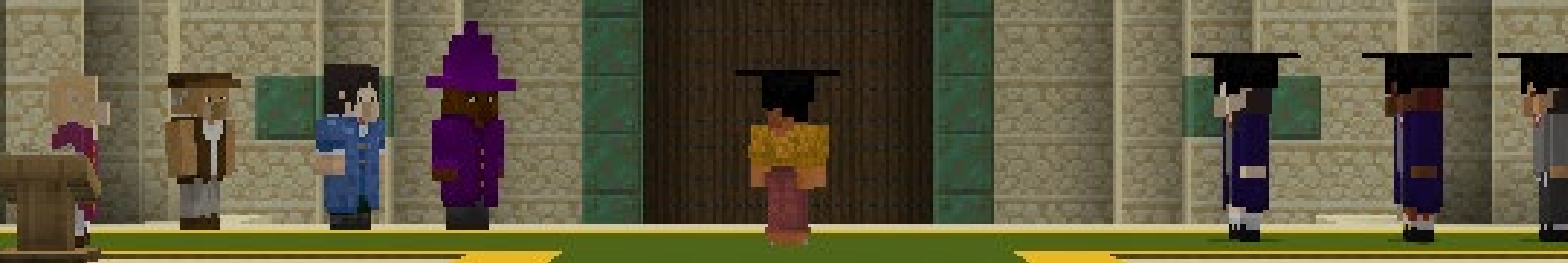


Version 2 (competitive)

Each game requires one 0–9 die (real or virtual) and some paper. Students can play one-on-one in pairs, or pair-on-pair in groups of four. The image of two "empty" fractions with a greater-than symbol in between should be drawn to begin the game. Teams take it in turns to roll the die four times and then insert the numbers from the rolls to create their own two fractions.

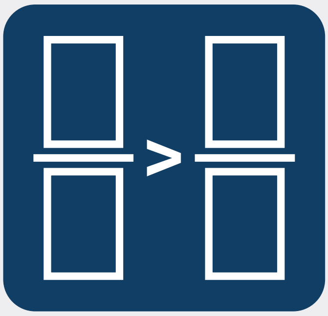
Scoring:
Competitive: 1 point if the expression is correct; that is, the left fraction represents a larger number than the right fraction.
Collaborative: Take those four rolled numbers and rearrange them to make another true but different statement. Both get 1 point each if correct.





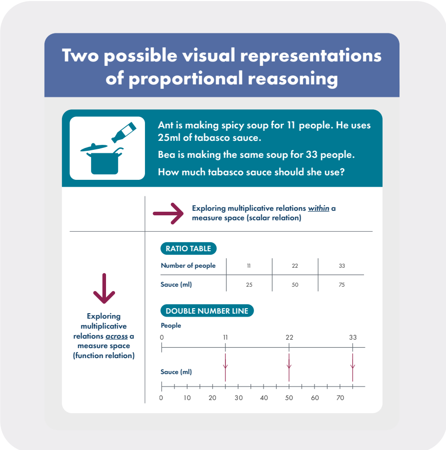
Version 3 (advanced)

Same setup as Version 2, but each student scores points equivalent to the fraction they create on the right. This is appropriate for students who are comfortable with adding fractions which may not have a common denominator. They will want the fraction on the right to be less than the one on the left but will still want to maximize it to get as many points as they can. For example, if a student rolls 2, 7, 4, and 1, then making the equation 2/1 > 7/4 yields more points than making the equation 4/7 > 1/2.



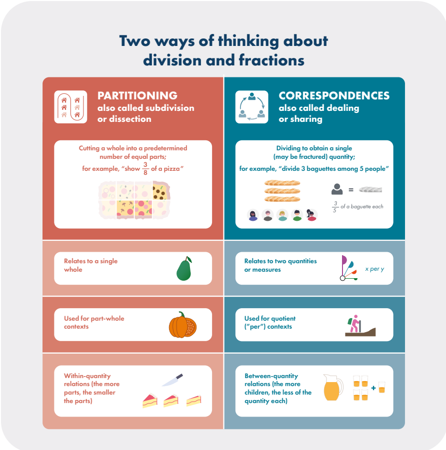
- Connect to NRICH tasks
  - **Age 7 to 11 Twice as big?** https://nrich.maths.org/problems/twice-big
  - **Age 7 to 11 Overlapping squares** https://nrich.maths.org/problems/overlapping-squares
  - **Age 11 to 16 Countdown fractions** https://nrich.maths.org/problems/countdown-fractions

Further reading from Cambridge Mathematics



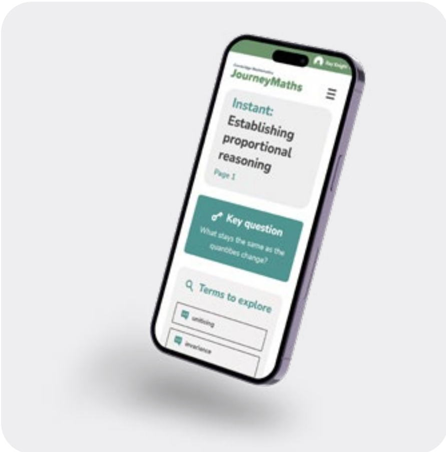
Espresso 28 – What does research suggest about the development of proportional reasoning in mathematics learning?

Read Espresso 28



Espresso 40 – What does research suggest about the teaching and learning of fraction equivalence?

Read Espresso 40



JourneyMaths – Sign up for a free account and view the Instant: Establishing proportional reasoning

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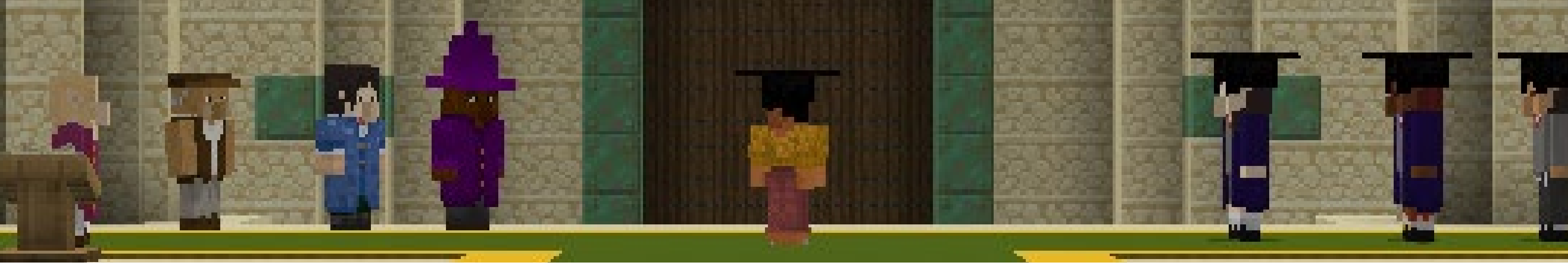


Curriculum connection examples

The following are examples of curriculum standards to which this activity could contribute:

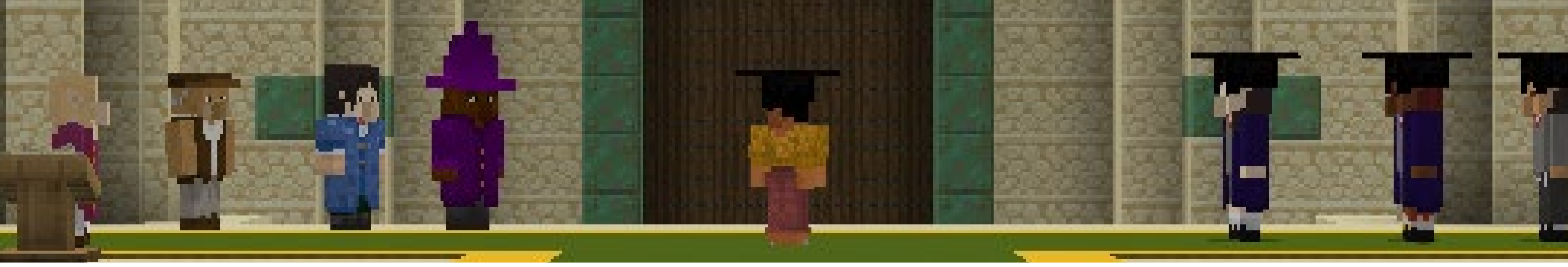
Common Core Mathematics Standards (United States)

- CCSS.Math.Content.4.MD.A.2 “Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.”
- CCSS.Math.Content.4.NF.A.2 “Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as ½. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.”
- CCSS.Math.Content.4.NF.B “Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.”
- CCSS.Math.Content.4.NF.B.4.A “Apply and extend previous understandings of multiplication to multiply a fraction by a whole number: Understand a fraction a/b as a multiple of $1/b$. For example, use a visual fraction model to represent $\frac{5}{4}$ as the product 5 x (¼), recording the conclusion by the equation $\frac{5}{4}$ = 5 x (¼).”
- CCSS.Math.Content.4.NF.B.4.C “Solve word problems involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem.”

National Curriculum in England

“Pupils should be taught to”:

- **Lower Key Stage 2, Year 4 Number** – fractions (including decimals): “solve problems involving increasingly harder fractions to calculate quantities, and fractions to divide quantities, including non-unit fractions where the answer is a whole number”
- **Upper Key Stage 2, Year 5 Number** – fractions (including decimals and percentages): “recognise mixed numbers and improper fractions [fractions with a numerator greater than the denominator] and convert from one form to the other and write mathematical statements > 1 as a mixed number [for example, ⅖ + ⅘ = $\frac{6}{5}$ = 1⅕]”
- **Upper Key Stage 2, Year 5 Number** – fractions (including decimals and percentages): “multiply proper fractions and mixed numbers by whole numbers, supported by materials and diagrams”
- **Lower Key Stage 2, Year 3 Number** – multiplication and division: “solve problems, including missing number problems, involving multiplication and division, including positive integer scaling problems and correspondence problems in which n objects are connected to m objects”
- **Lower Key Stage 2, Year 4 Number** – multiplication and division: “solve problems involving multiplying and adding, including using the distributive law to multiply two-digit numbers by 1 digit, integer scaling problems and harder correspondence problems such as n objects are connected to m objects”



Acknowledgements

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Credits

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