Early knowledge of numbers: path or barrier to understanding fractions and decimals?

Vana Avgerinou
Putney High Junior School & UCL Institute of Education

INTRODUCTION

Proficiency with fractions and decimals predicts later achievement in mathematics and occupational success. However, these concepts pose large difficulties for many learners even in countries that rank high in international tables of mathematical achievement. Some findings suggest that the whole numbers that make up a fraction or decimal prompt children to treat them as separate quantities rather than a unified whole. A common misconception is to reason that 2/7 is greater than 2/5 because 7 is greater than 5, or that 1.25 is greater than 1.3 because 25 is greater than 3.

Illustrations and cognitive load

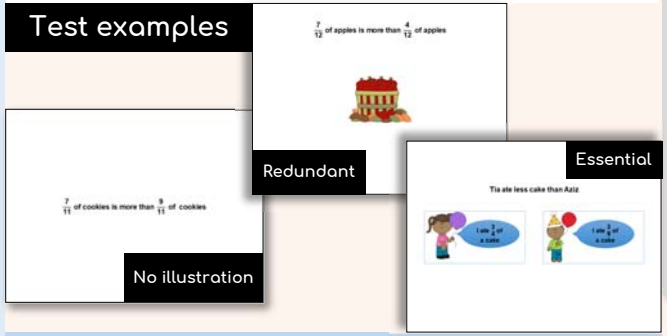
Mathematical tasks are often accompanied by illustrations. This study investigated if illustrations increase cognitive load, leaving fewer resources available to inhibit prior whole number knowledge, leading to poorer performance.

RESEARCH QUESTIONS

- Does the accuracy and speed of performance vary for fraction and decimal pairs that are inconsistent with whole number ordering compared to consistent pairs?
- Do illustrations affect the speed and/or accuracy of performance in the magnitude comparison task?

METHODOLOGY

95 children aged 8-10 were tested on a computerised fraction and decimal magnitude comparison task. In half of the trials (N=24) the comparison pairs were inconsistent with whole number ordering and consistent in the rest. Consistent and inconsistent pairs were presented without illustrations ('Bare', no load, N=16), with a decorative illustration ('Redundant', low load, N=16) or with two illustrations that contained numerical information that was essential to answering the question ('Essential', high load, N=16).



Do children misapply their knowledge of whole numbers to fractions and decimals?

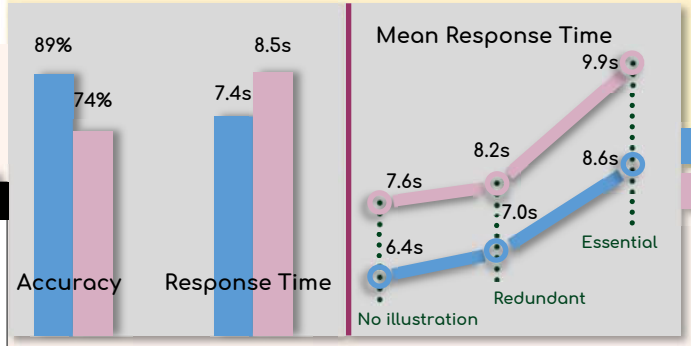
Two sets of problems were created to test it

Consistent with whole number knowledge (automatic processing)	Inconsistent with whole number knowledge (effortful processing because of competing demands)
$\frac{7}{9} > \frac{2}{9}$ (because 7 > 2)	$\frac{2}{7} < \frac{2}{5}$ (even though 7 > 5)
1.2 < 1.35 (2 < 35)	1.25 < 1.3 (even though 25 > 3)

RESULTS

- Children took significantly longer and were less accurate in comparing the magnitude of fraction and decimal pairs that were inconsistent with whole number ordering compared to consistent trials.
- Children were significantly faster in comparing the magnitude of fraction and decimal pairs in trials without illustrations compared to trials with redundant and essential illustrations.

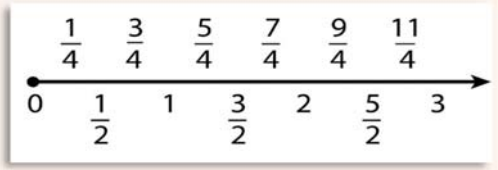
Illustrations slowed down processing



Prior knowledge can be a barrier to new learning

CONCLUSIONS

- Knowledge of whole numbers that has helped children secure basic number facts in the first years of schooling interferes with their efforts to understand fractions and decimals that go against early understandings of number.
- Adding illustrations to mathematical tasks may unnecessarily increase the difficulty of a task, especially a task that is at odds with children's prior knowledge.
- New research suggests that teaching children to order fractions on a number line significantly improves their ability to compare fractions compared to teaching using the area ("pizza") model.



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