Wait, there's letters now?!
Motivating early algebra understanding

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Instructional Designs

Motivated Concreteness Fading (MCF)

1. Begins with **concrete, purposeful stories** to *motivate learning* (Ainley, 2012)

2. Students first **attempt** each problem type on their own, followed by **scaffolded instruction**

3. Word equation notation scaffolds **concreteness fading** and *motivates the use of variables*

Day 1: **The price of 2 slices of cheese pizza + the price of 1 bottle of water = $5.00**
Day 2: **The price of 4 slices of cheese pizza + the price of 1 bottle of water = $9.50**

4. Formal variables introduced ***last***, as an *easier notation system* to work with

2*p* + 1*w* = $5.00
4*p* + 1*w* = $9.50

Formalism Contextualizing (FC)

1. Formal variables introduced ***first,*** in *general, abstract* terms

Variable:
- A *symbol* that represents a *number*
- Usually a *letter*, like **x** or **y**
- Can represent a number we don't know yet

2. Variables are then **contextualized within** and **exemplified across** *multiple concrete story problems*

Goals:
*Figure out **how much money** 1 **slice of pizza** costs*
*Figure out **how much money** 1 **bottle of water** costs*

p ——————→ **the price of 1 slice of pizza**
w ——————→ **the price of 1 bottle of water**

3. For each problem type, a **worked example** is given first, *then* students solve an analogous problem

2*p* + 1*w* = $5.00 **4*p* + 1*w* = $9.50** **p = ???** **w = ???**

Middle schoolers often **struggle to understand the purpose of variables** when learning algebra

How can we help them learn?

Maybe using **system-of-equations** problems set in **purposeful story contexts**

This might also improve **conceptual understanding** of algebraic variables

Methods

- randomly assigned U.S. **6th-** and **7th-grade** students to the MCF, FC, or positive control (Khan Academy) modules (**online videos**).
- Dependent measures: **delayed post-test** of **conceptual** knowledge and **transfer** to analogous and more difficult system-of-equations problems
- Data collection is *ongoing* this school year (intended *n* = 100).

Hypothesized Results

Post-Test: MCF > FC > Ctrl

Because:

- Introducing formalisms **gradually** better helps students to understand the conditions under which to apply formalisms (Fyfe et al., 2015; Nathan, 2012)
- There is a "**time for telling**" – students learn best if new information is introduced when it is needed (Schwartz & Bransford, 1998)
- Students in all conditions benefit from system-of-equations lessons

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