### Improving Visual and Verbal Information Integration in Mathematics Textbooks

Clinton, V., Cooper, J. L., Alibali, M. W., & Nathan, M. J. (2013, July). Improving visual and verbal information integration in mathematics textbooks. Poster presented at the Annual Midwest Meeting on Mathematical Thinking in Minneapolis, MN.

Virginia Clinton, Jennifer L. Cooper, Martha W. Alibali, & Mitchell J. Nathan
University of Wisconsin - Madison

### INTRODUCTION

Like many math textbooks, Connected Mathematics 2 has a wide variety of visuals.

We sought to improve the integration of visual and verbal information in modifying the CMP2 books.

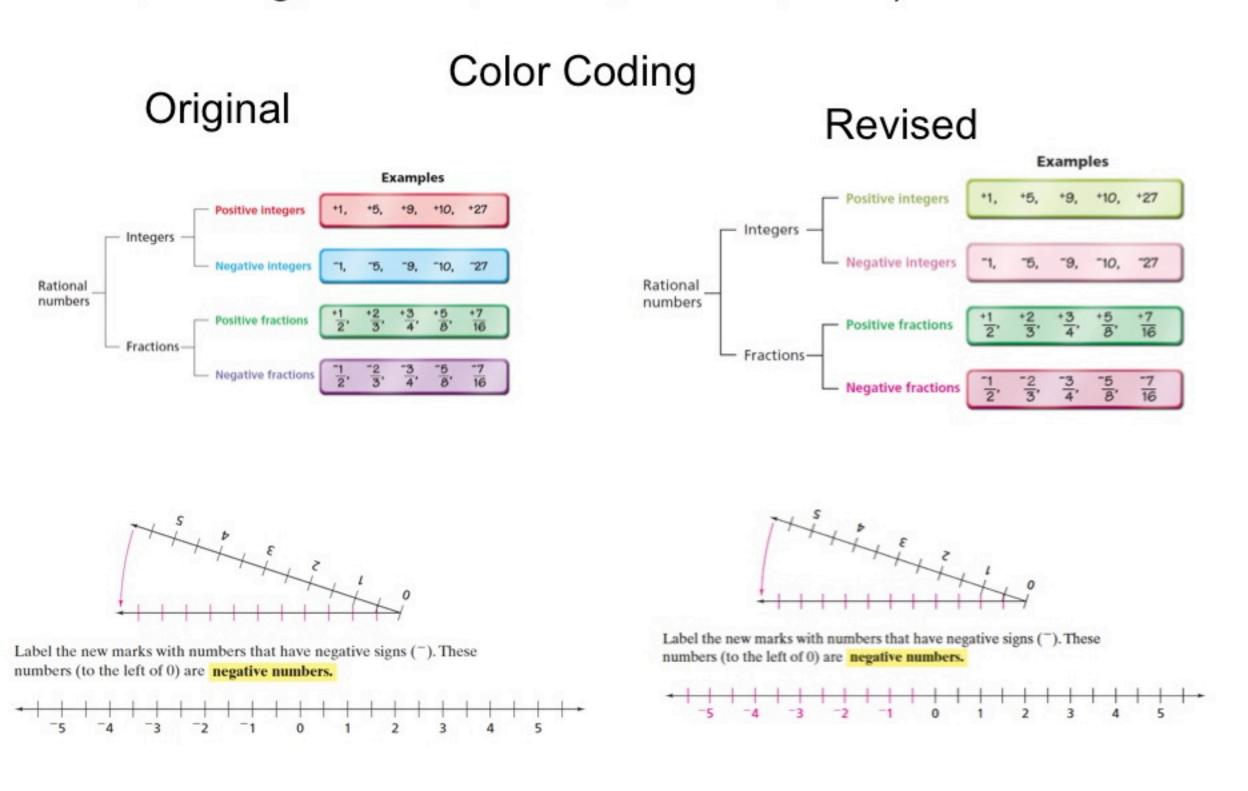
We based these modifications on three cognitive principles: signaling, contiguity, & coherence (Mayer, 2009).

Now we are in the process of empirically testing these modifications to determine their effectiveness.

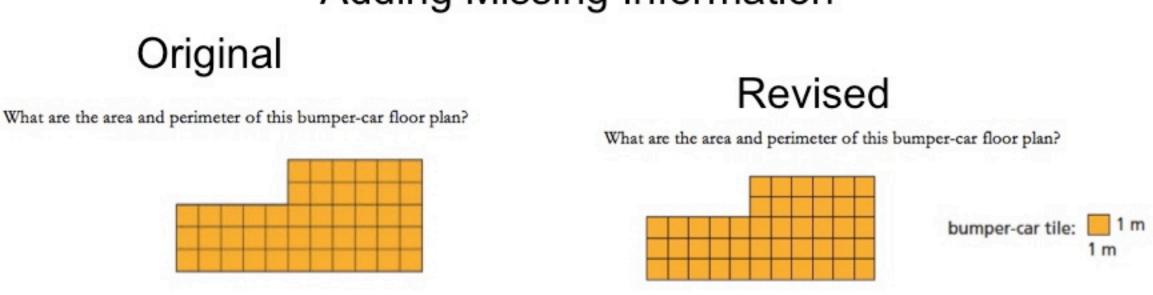


### **Signaling Principle**

Learning is improved when there are cues to important information (Kalyuga, Chandler, & Sweller, 1999; Koning, Tabbers, Rikers, & Paas, 2009).



### Adding Missing Information



The research reported here was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305C100024. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

### **Contiguity Principle**

Learning is improved when multiple representations are aligned along important features (Ginns, 2006; Mayer, 2002).

# Shared Spatial Layout Original Revised The camp dining room has two kinds of tables. A large table seats ten people. A small table seats eight people. On pizza night, the students serving dinner put four pizzas on each large table and three pizzas on each small table.

### **Spatial Contiguity**

### Original

The problems and the table necessary to solve the problems are on different pages.

## Tree Type | Circumference (ft) | Height (ft) | Spread/Diameter (ft) | Giant Sequoia (Calif.) | 83.2 | 275 | 107 | Coast Redwood (Calif.) | 79.2 | 321 | 80 | Swamp Chestnut Oak (Tenn.) | 23.0 | 105 | 216 | Florida Crossopetalum (Fla.) | 0.4 | 11 | 3 | White Oak (Md.) | 31.8 | 96 | 119 | Suma: Weshington Fost | Problem | Writing Comparison Statements A. Use the table above. 1. How many coast redwood spreads does it take to equal the spread of the white oak? 2. Kenning says that the spread of the white oak is greater than that of the coast redwood by a ratio of about 3 to 2. Is he correct? Explain. 3. Mary says the difference between the heights of the coast redwood and the giant sequoia is 46 feet. Is she correct? Explain. 4. How many giant sequoia spreads does it take to equal the spread of the swamp chestnut oak? 5. Jaime says the spread of the giant sequoia is less than 50% of the spread of the swamp chestnut oak. Is he correct? 6. Len says the circumference of the swamp chestnut oak is about

three fourths the circumference of the white oak. Is he correct?

Revised

### Integrate Verbal and Visual Information

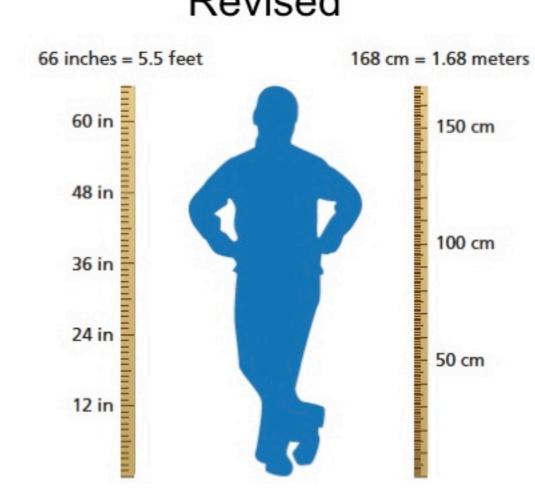
Original						Revised								
Jumping Jacks Over Time							Jumping Jacks Over Time							
* <b>y</b>							Number of Jumping Jacks					repres	ent	
				X							П		X	
Time (seconds)						Time (seconds)								

### **Coherence Principle**

Learning is improved when interesting, but irrelevant words and pictures are removed (Harp & Mayer, 1998; Mayer, 2002).

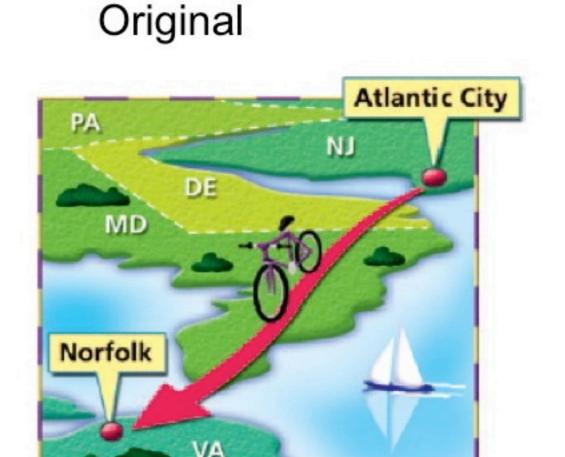
### Replace Math-Irrelevant with Math-Relevant Original Revised





### **Coherence Principle (continued)**

### Remove Seductive Details





Julia says that sometimes she uses estimation to decide where to place the decimal in an actual product. With the problem 0.9 × 1.305, a reasonable estimate is 1 × 1.3 = 1.3. Even 1 × 1 is a good estimate. I think that the actual product is a little more than 1. When I multiply 9 × 1,305 I get 11,745, so I know the actual product is 1.1745.

Use Julia's estimation strategy to find the product N

the actual product is 1.1745.

Use Julia's estimation strategy to find the product N.

a. 31.2 × 2.1 = N

b. If 6,946 × 28 = 194,488, then

694.6 × 2.8 = N.



Julia says that sometimes she uses estimation to decide where to place the decimal in an actual product. With the problem  $0.9 \times 1.305$ , a reasonable estimate is  $1 \times 1.3 = 1.3$ . Even  $1 \times 1$  is a good estimate. I think that the actual product is a little more than 1. When I multiply  $9 \times 1,305$  I get 11,745, so I know the actual product is 1.1745.

Use Julia's estimation strategy to find the product N.

a. 31.2 × 2.1 = N

b. If 6,946 × 28 = 194,488, then

694.6 × 2.8 = N.

### **Empirical Tests**

Two experiments to examine the effects of the revisions: Problem solving and lesson reading.

### Problem solving:

- -50 seventh-grade students
- -8 story problems (4 revised and 4 original; between and within subjects)
- -Revisions did not affect problem-solving accuracy
- -Revisions also did not affect student's reports of their level of interest, confusion, or perceived difficult
- -Problem solving may involve different processing than does reading lessons.
- -More research needs to be done to reconcile these findings with others on the seductive details effect.

### Lesson reading:

- -In progress with sixth- and seventh-grade students
- -Read lesson (original or revised) while eye movements were recorded, wrote recall, solved problems
- -Preliminary eyetracking data indicate revised lessons were easier to read than original lessons.

The findings from these experiments will contribute towards refining cognitive principles for future revisions.

