Methods of division: What works best for fourth grade students?

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Introduction

Students in Newfoundland are introduced to division in grade 3. According to local grade 3 teachers students:
- Are not required to memorize division facts
- Only deal with problems as large as $25 \div 5$
- Are taught that there are 4 ways to understand division
  - Equal Sharing (ES)
  - Equal Grouping (EG)
  - Repeated Subtraction (RS)
  - Inverse Multiplication (IM)

Teachers report focusing most on ES & EG.

Past Literature
- Focus on 5-7 year olds, prior to formalized teaching of division
- Most involve EG and ES, where the goal is in the child's understanding of dividend, divisor, and quotient
- Students find ES to be easier than EG (Correa, Nunes, & Bryant, 1998; Kornilaki & Nunes, 2005)

Goals/Hypotheses

First, which method(s) do grade 4 students use most after being taught the 4 methods listed above in grade 3?
- Hyp 1: ES & EG are expected to be most used by grade 4 students.

Second, which method(s) resulted in the most accuracy?
- Hyp 2: ES expected to result in most correct answers.

Third, are the method(s) used for easy questions generalized to harder questions?
- Hyp 3: Methods expected to be as likely to be used for hard questions as they are for easy questions.

Methods

Participants: 30 fourth grade boys (N=10) and girls (N=20) with a mean age of 9.64 years (s = .32), recruited from schools in Eastern and Central Newfoundland

Procedure: Each child was individually tested in a one-on-one interview setting lasting between 10-30 minutes. The children were instructed to answer the 10 computational division problems of varying difficulty (Table 1) using any method(s) of their choosing. After each problem the child was asked how they found the answer. Their responses were recorded for later coding of method use.

Table 1. *Question difficulty.*

Easy	Hard
$6 \div 2$	$32 \div 8$
$8 \div 4$	$35 \div 5$
$15 \div 3$	$56 \div 7$
$20 \div 5$	$54 \div 7$
$12 \div 4$	$81 \div 9$

Results

Eight methods were coded. One-third of booklets by an independent coder ($\kappa = .978$)
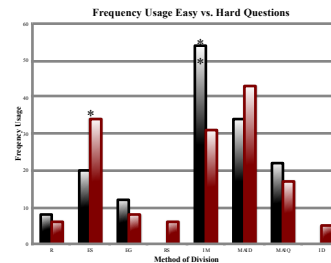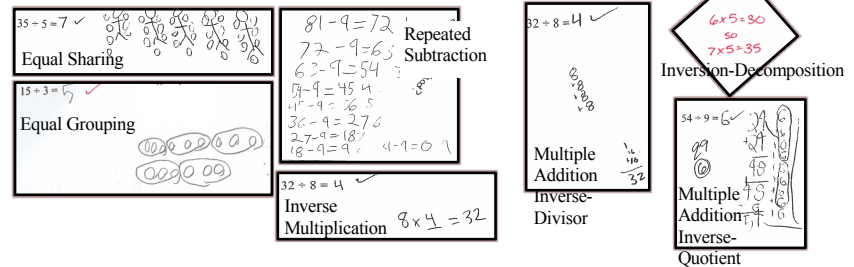
Note: $*$ $p < .05$, $**$ $p = .001$, t-test based on means
- Friedman test: IM was used more frequently than RS, $\chi^2(1) = 2.3$, $p = .008$; R, $\chi^2(1) = 1.983$, $p = .048$; and ID, $\chi^2(1) = 2.3$, $p = .008$ (adj. p-values)
- Friedman test: MAID used more frequently than RS, $\chi^2(1) = 2.35$, $p = .006$; R, $\chi^2(1) = 2.033$, $p = .037$; and ID, $\chi^2(1) = 2.350$, $p = .006$ (adj. p-values)
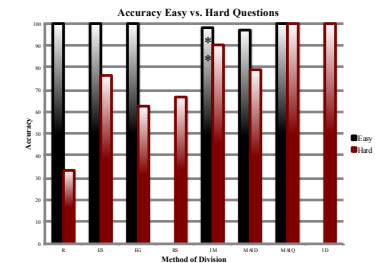
Note: $**$ $p < .001$, t-test based on means
- Regardless of method, children correctly answered more easy (M = 4.93, SD = .25) than hard questions (M = 4.03, SD = .96), $t(29) = 5.137$, $p < .001$
- Friedman test: IM resulted in more correct answers than RS, $\chi^2(1) = 2.217$, $p = .013$; R, $\chi^2(1) = 1.983$, $p = .048$; and ID, $\chi^2(1) = 2.183$, $p = .016$ (adj. p-values)
- Friedman test: MAI-D resulted in more correct answers than RS, $\chi^2(1) = 2.25$, $p = .01$; and R, $\chi^2(1) = 2.017$, $p = .04$; and ID, $\chi^2(1) = 2.217$, $p = .013$ (adj. p-values)

Discussion

- Grade 4 students used unexpected methods when solving computational division problems. Some were even used more than the methods taught in grade 3.
- Hyp 1: Not supported, IM was found to be the most frequently used method for solving the given computational division problems.
- Hyp 2: Not supported, IM resulted in the most correct answers when ES was expected to result in the most correct answers. There was also no difference in accuracy between ES and EG which is consistent with Squire & Bryant, 2002, even though previous literature report ES to be easier than EG (Correa et al., 1998; Kornilaki & Nunes, 2005).
- Hyp 3: Partially supported. All methods except ES and IM showed no difference in performance between easy and hard question suggesting a degree of generalization.
- Despite teachers' reports of focusing on ES and EG, two-thirds of the problems were solved using an inversion method (i.e., IM, MAI-D, and MAI-Q).
- It is interesting that IM was used most frequently and resulted in the most correct answers given that students in Newfoundland are not required to memorize multiplication and division facts. Many students reporting learning this information from their parents.
  - Children's math performance can benefit from memorization of multiplication and division facts.