Children's Use of Media in School:
Enabling Access to Advanced Mathematics

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Overview

- Black Box: The Case of Graphing
  We have large scale data demonstrating powerful effects.
- Inside the Black Box: The Role of Design
  Effective media designs link to social cognition
- Intervention Research: A Scale Up Study
  High quality classroom research is complex
- What We Need: Longitudinal Studies of Children
  Effects on children across environments not understood.

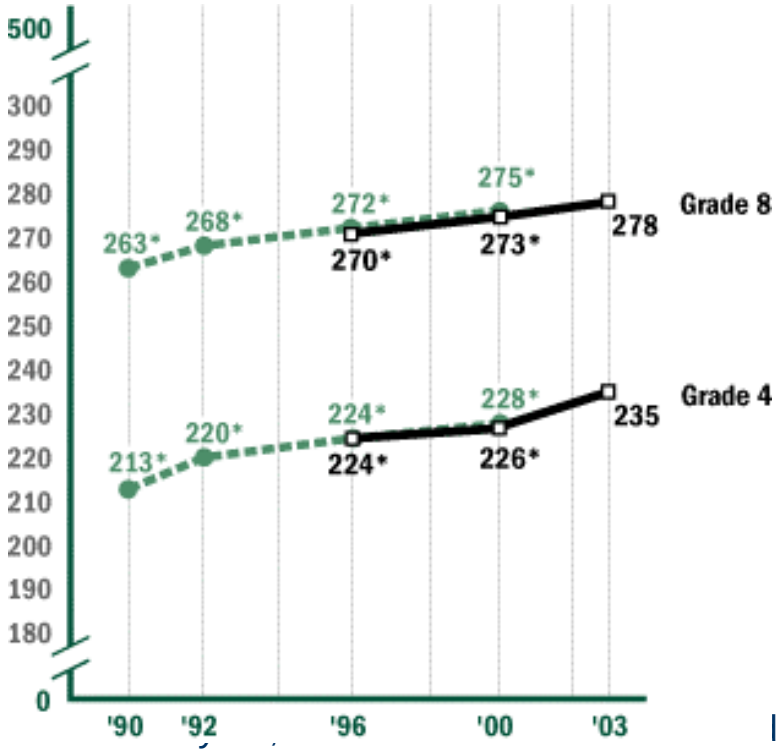
Pop Quiz

Over the past 20 years, mathematics achievement of US 8th graders has been:

A. Improving?
B. Declining?
C. Staying the Same?

National Assessment of Educational Progress (NAEP) Shows Improvement

Average mathematics scale scores, grades 4 and 8: 1990–2003



At least a grade level of improvement since 1996

-- Judy Sowder

Data analysis strand shows particular growth

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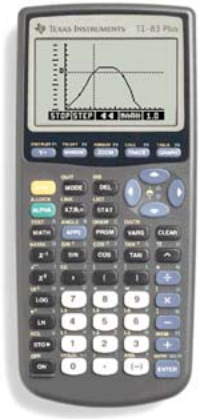
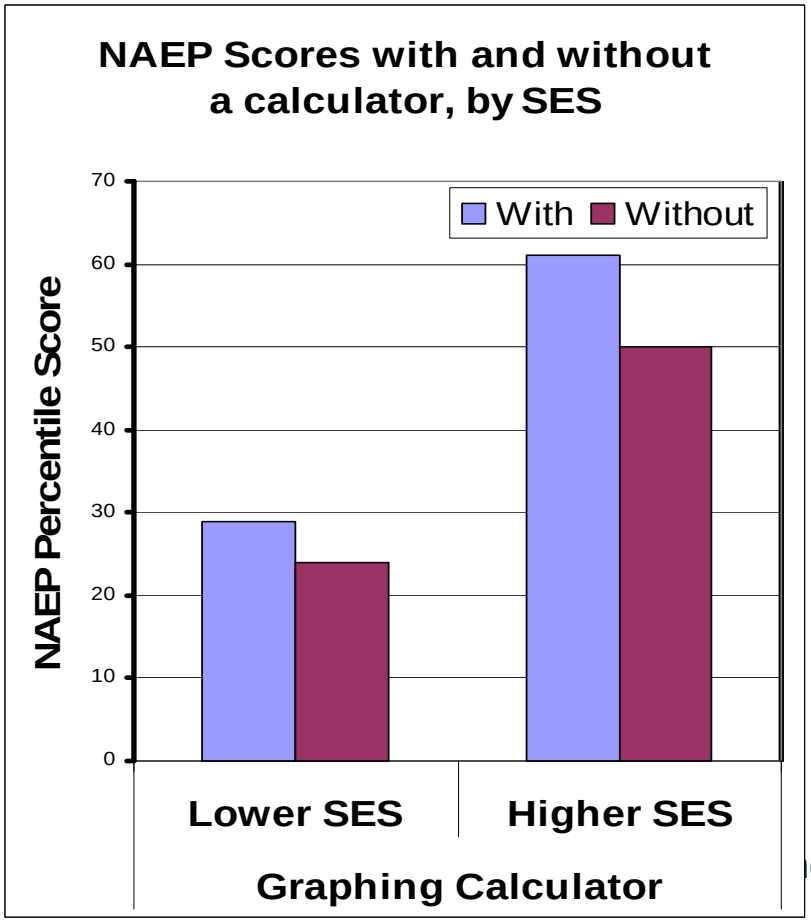


The Case of Graphing Calculators:

Behind SES, a significant correlate of high performance



"Eighth-graders whose teachers reported that calculators were used almost every day scored highest. Weekly use was also associated with higher average scores than less frequent use. In addition, teachers who permitted unrestricted use of calculators and those who permitted calculator use on tests had eighth-graders with higher average scores than did teachers who did not indicate such use of calculators in their classrooms." NCES, 2001

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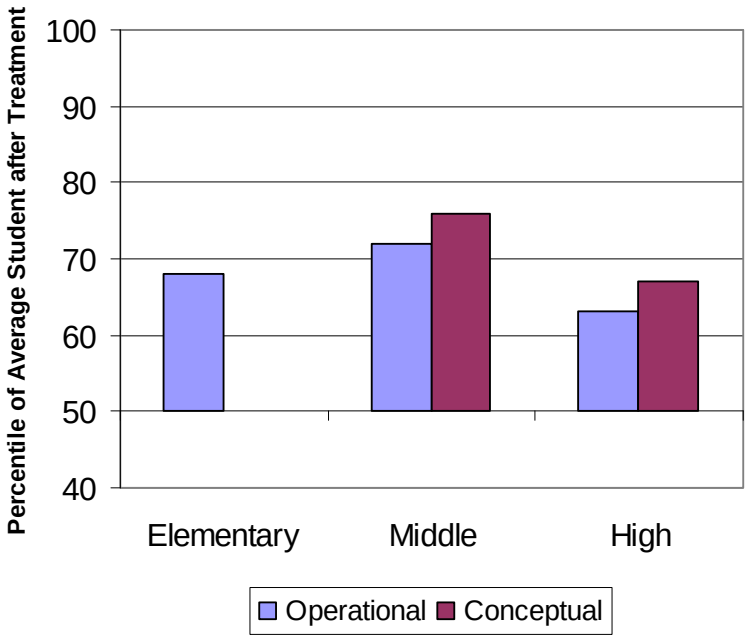
Supported by Experimental Studies



Ellington's metaanalysis of 54 experiments:

- Gains across grade levels
- Operations
- Conceptual understanding
- Problem Solving

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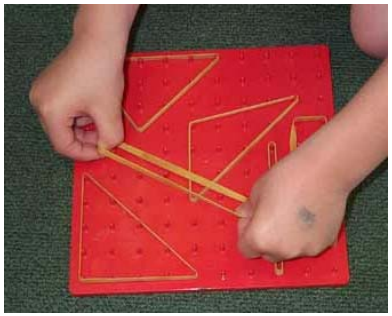
Supported by Theory

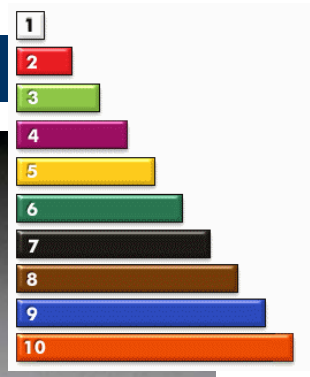
- Dual coding theory of multimedia (Mayer, 1994)
- Interactive Graphics (Marzano, 1998)
- Construction & Manipulation (Dienes, 1960)

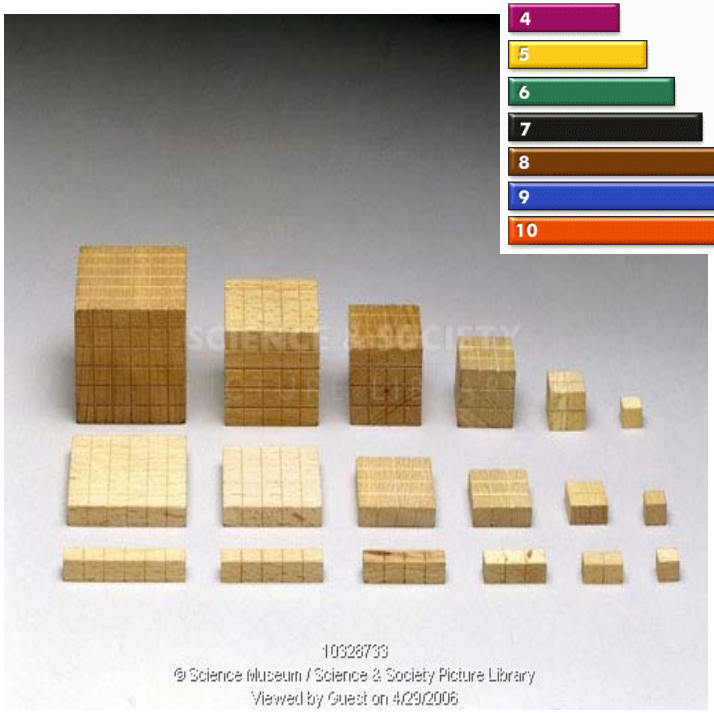
Inside the Black Box: The Role of Design



Dienes Principles

- Construction / Manipulation
- Multiple Embodiments
- Isomorphic Structure
- Perceptual Variability





We have been designing and using media in elementary mathematics for a long time!

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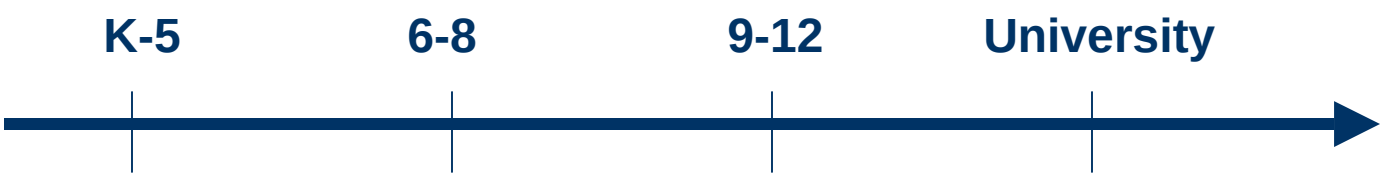
From Manipulatives to Powerful Tools



Manipulatives

Mathematica, AutoCAD, SPSS

Virtual Manipulatives → Modeling Tools

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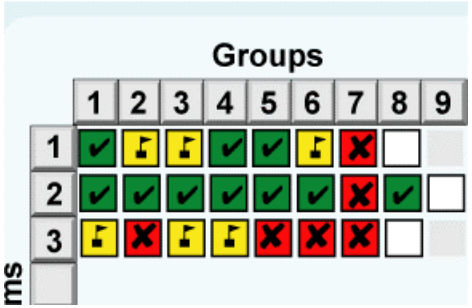
Demonstration: TinkerPlots

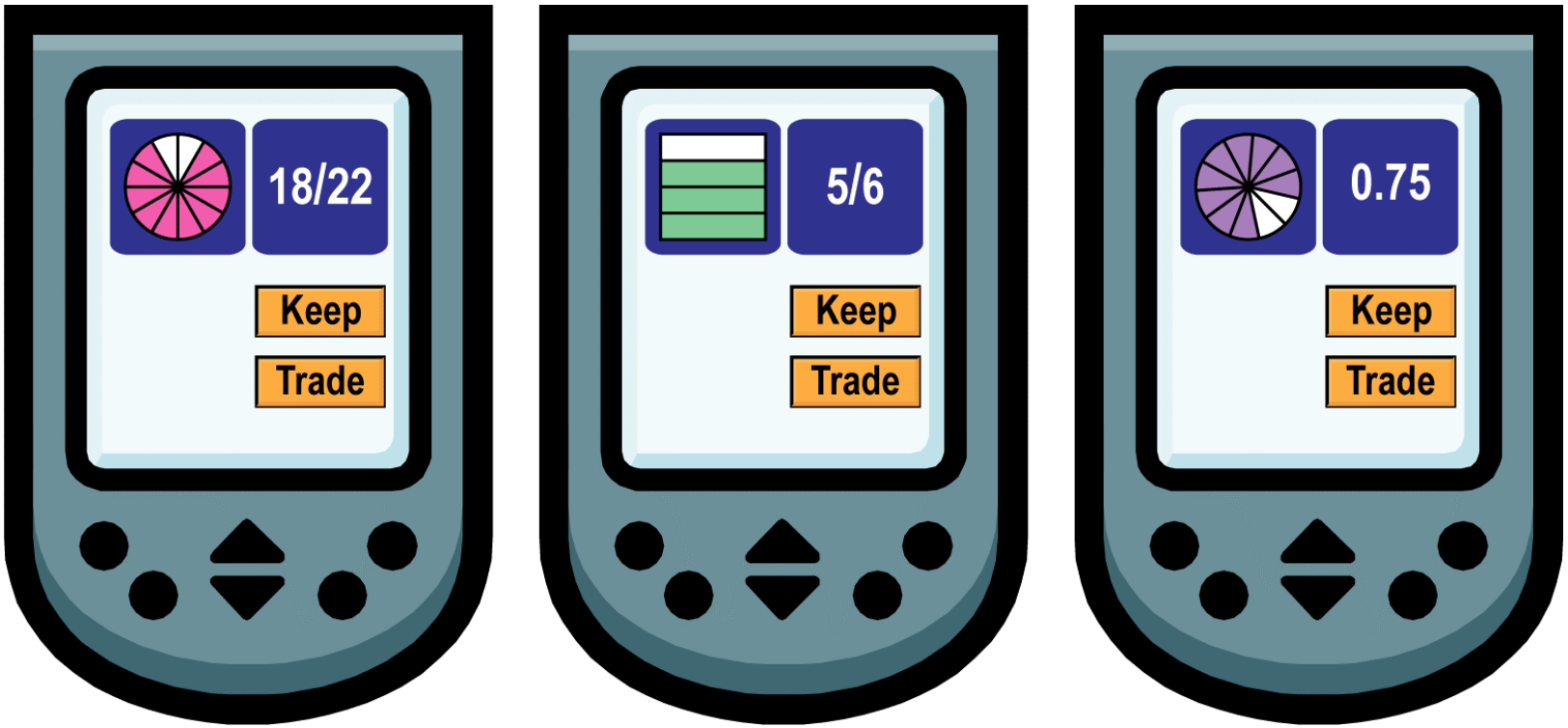
Building Blocks for Data Analysis Cognition

- Separate
- Order
- Sort

Note: Implies new relationships among teachers, students and resources

Discourse and Peer Learning: Nussbaum's Work





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Discourse and Peer Learning: Principles

- Positive Interdependence
- Individual Accountability

If these factors are present, strong gains in learning occur!
(Johnson & Johnson, 1987; Slavin, 1996)

Learning plus small group skills

In a high school classroom…

Intervention Research: A Scale Up Study

- Question: Do gains scale to a *wide variety* teachers?

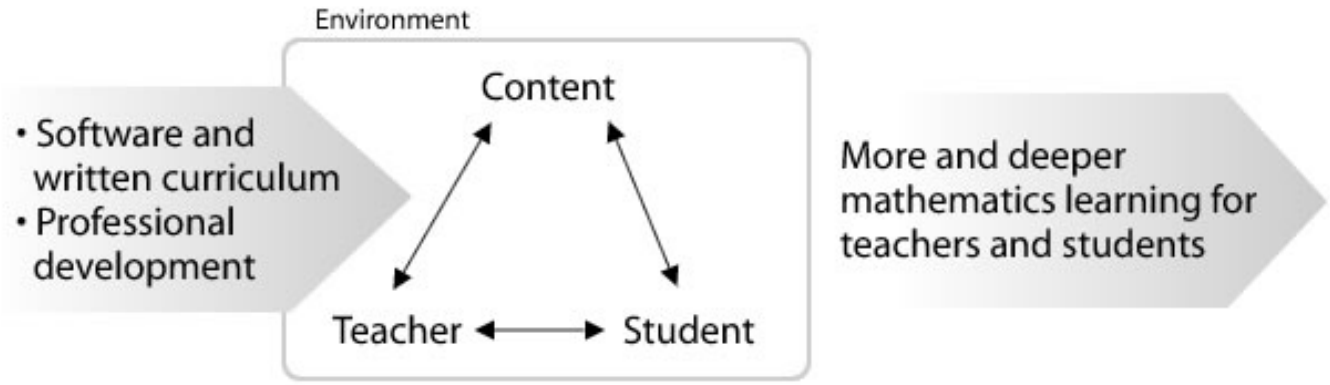
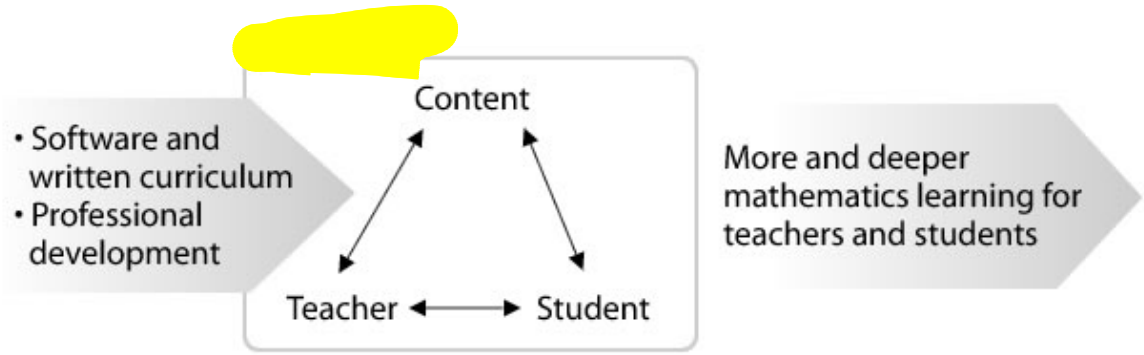


Figure 1: Intervention Logic (adapted from Cohen, et. al. 2003)

The Environment

- Align to Standards, Assessments
- Provide Professional Development



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Measurement

- MKT
- Observations, Logs
- Student Tests

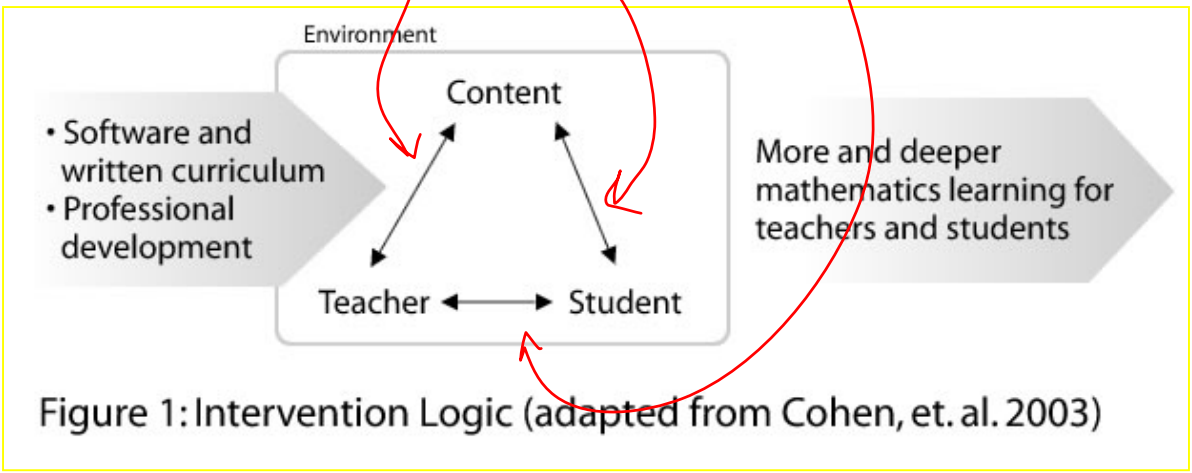


Figure 1: Intervention Logic (adapted from Cohen, et. al. 2003)

Analysis: Hierarchical Linear Modeling

- Variance at student, classroom, school levels

How and when are we democratizing?

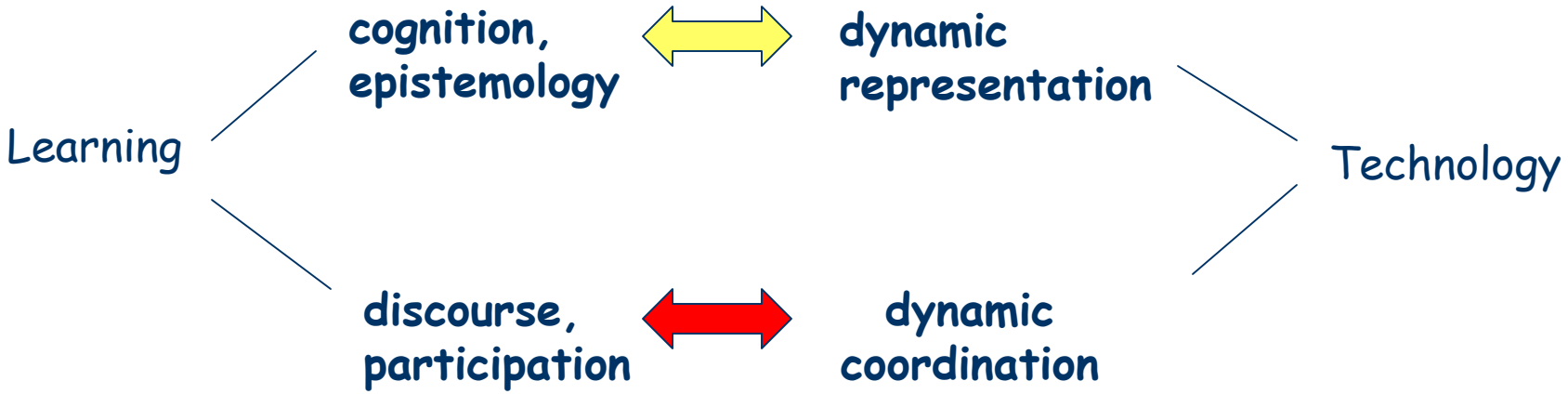
Two meanings:

1. The classroom average in a weak classroom goes up more
2. Within any classroom, the weak students learn more

Summary

- At scale, technology *is* making a difference, but not all technology.
- Design matters. Two key areas: interactive representations and dynamic coordination
- From simplistic to complex: Need sophisticated studies to answer policy questions

In school, media can *mediate* learning of important and complex concepts



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What could NIH do?

- Awareness of NSF and Dept of Ed role
- Really important missing question: longitudinal and cross-context studies

- Different schools, classes, years, etc.