EXAMINING MATHEMATICS COACHING

Research and Impacts in K-8 Mathematics Coaching

David Yopp, John Sutton and Clare Heidema

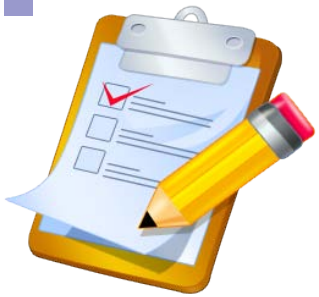
National Council of Teachers of Mathematics
Research Conference
Philadelphia
April 2012

Research Partners

MONTANA STATE UNIVERSITY

RMC RESEARCH

Funding By The National Science Foundation
Discovery Research K-12 Program (DR K-12),
Award No. 0918326

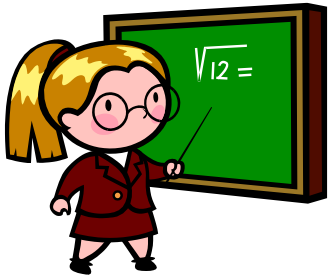


Session Agenda

- Description of Examining Mathematics Coaching (EMC) project
- Effects of Coach MKT on Teacher MKT
- Effects of Teacher MKT on practice
- Effects of Coaching on Student Achievement

Mathematics Coaching

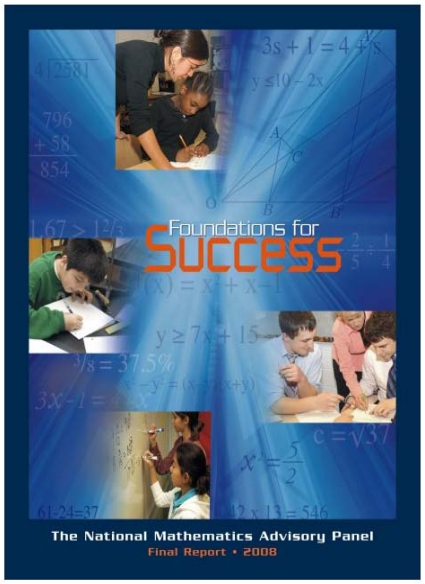
Mathematics classroom coaching
is gaining popularity as a
school-based effort
to increase
teacher effectiveness
and
student achievement.



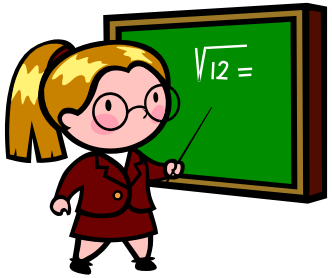
WHY STUDY COACHING?

- Coaching is a promising model for enhancing K-8 mathematics teachers' abilities to provide quality mathematics education.
- Coaching can be implemented at any point in a teacher's career (as opposed to mentoring).

WHY STUDY COACHING?



The National Mathematics Panel (2008) reports that schools across the nation are using mathematics specialists, including mathematics coaches, yet there is **limited research proving what makes coaching effective.**



Why Study Coaching?

- There is limited understanding of coaching effectiveness, especially in mathematics.
- Moreover, no studies have demonstrated what types and depths of knowledge effective coaches hold.
- At the same time, implementing coaching involves considerable cost and logistical effort for schools and districts.

EXAMINING MATHEMATICS COACHING PROJECT

EMC is a five-year research and development project funded by NSF examining the effects of a coach's "knowledge for coaching" on a diverse population of K-8 teachers.

Contributors & Other Personnel

Montana State University

- David Yopp, PI
- Beth Burroughs, Co-PI
- Jennifer Luebeck
- Mark Greenwood

RMC Research

- John Sutton, Co-PI
- Clare Heidema
- Arlene Mitchell
- Dan Jesse

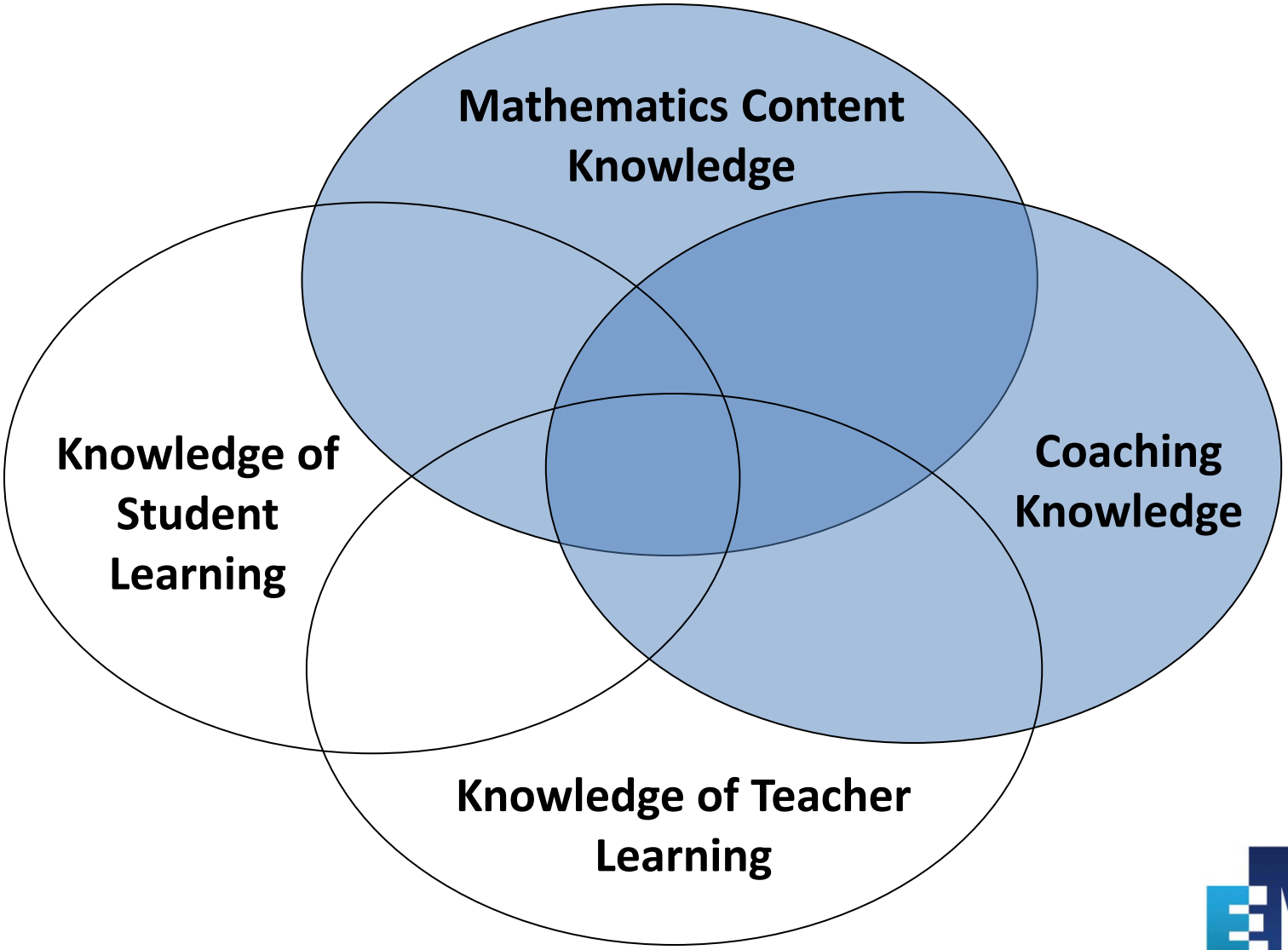
- James Burroughs, Project Director

Funded under *NSF Award No. 0918326. Any opinions expressed herein are those of the authors and do not necessarily represent the views of the National Science Foundation.*

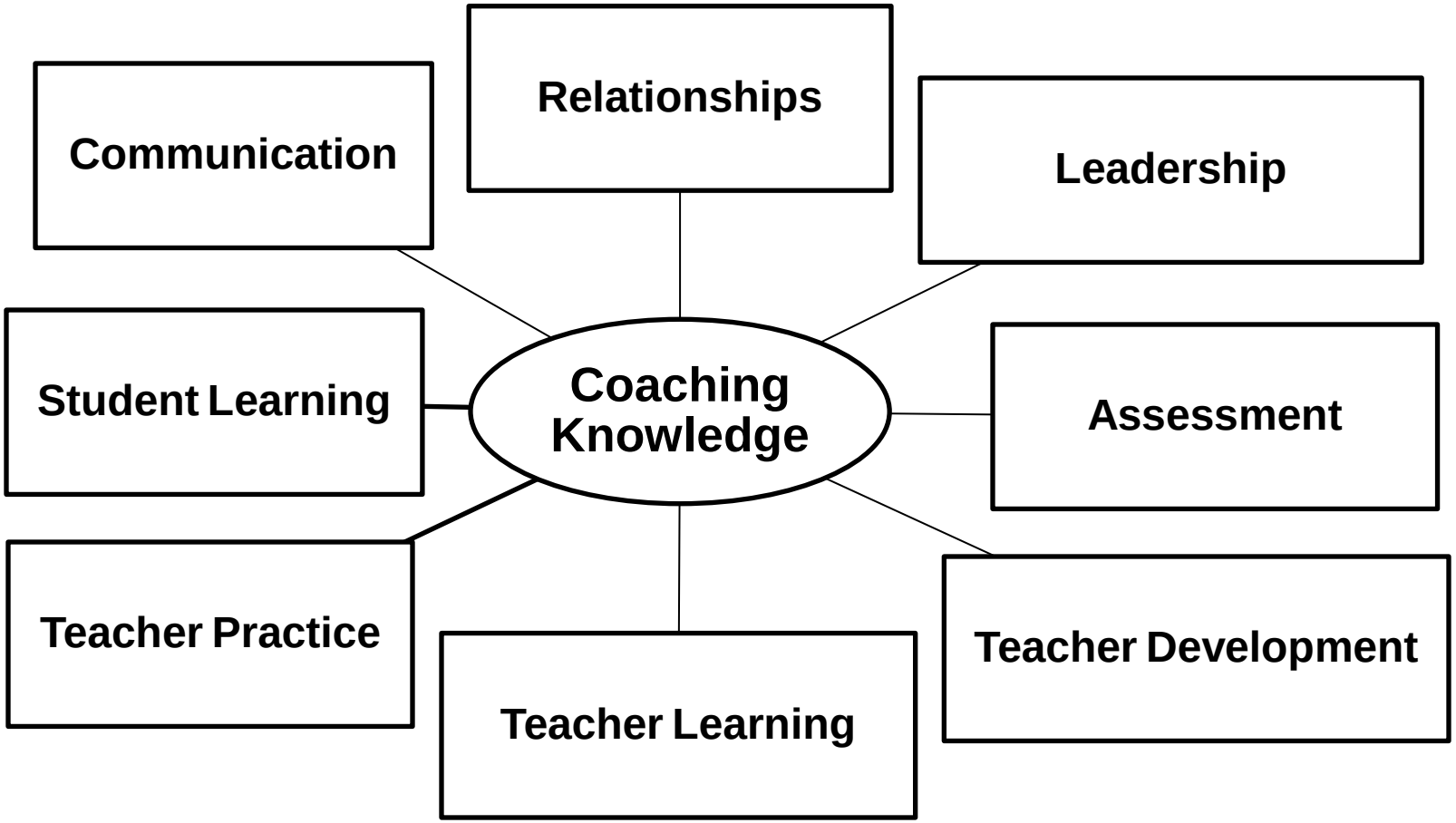
The Examining Mathematics Coaching Project (EMC)

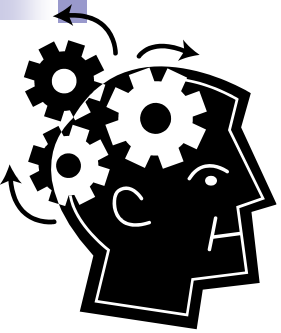
- Investigating knowledge that contributes to successful coaching in two domains:
  - Coaching knowledge
  - Mathematics content knowledge
- The influence of these knowledge domains is examined in two ways:
  - investigating correlations between assessments of coach and teacher knowledge and practice in each domain.
  - investigating causal effects of targeted professional development for coaches.

KNOWLEDGE DOMAINS



Coaching Knowledge Domains





EMC Research Hypothesis

- Effectiveness is linked to several domains of knowledge.
- Coaching knowledge and mathematics content knowledge contribute significantly to a coach's effectiveness.
- Effectiveness is measured by the positive impact on teacher practice, attitudes, and beliefs.

Crossover Design

	Group 1	Group 2
Year 1 2009-10	Provide orientation to EMC coaching model.	
Year 2 2010-11	• Provide PD on Mathematics Content Knowledge during Summer 2010 • Web-based PD School Year	• Web-based PD during School Year 2010-11
Year 3 2011-12	• Web-based PD during School Year 2011-12	• Provide PD on Coaching Knowledge during Summer 2011 • Web-based PD School Year
Year 4 2012-13	• Provide PD on Coaching Knowledge during Summer 2012 • Web-based PD School Year	• Web-based PD during School Year 2012-13
Year 5 2013-14	• Web-based PD during School Year 2013-14	• Provide PD on Mathematics Content Knowledge during Summer 2013 • Web-based PD School Year

Mathematics Coaching Defined

A mathematics coach is an **on-site professional developer** who enhances teacher quality through **collaboration** focusing on **research-based, reform-based, and standards-based instructional strategies and mathematics content** that includes the **why, what, and how** of teaching mathematics.

EMC Coaching Model

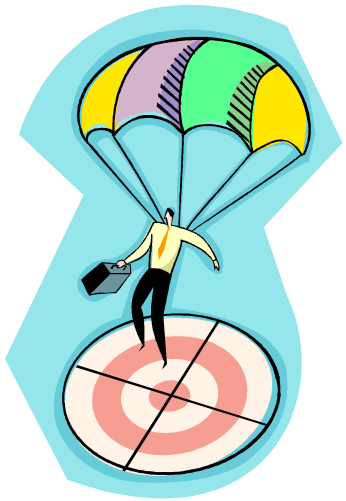
Coaching Cycle	•**Pre-conference** of at least 15 minutes focused on planning for upcoming lesson with emphasis on teacher's stated goals, objectives, and needs •**Observation** or model of a lesson •**Post-conference** of at least 30 minutes reflecting on planned teacher actions Coaching will focus on aspects of standards-based teaching as defined by NCTM process and content standards, not on generic pedagogy such as classroom management
Content Focus	Number and Operation; Ratio and Proportion
Frequency	Three teachers per coach provide data points for research. Teachers are coached at least 8 times per academic year with at least four of those times within the content focus.
Quality Assurances	Coach and teacher reflection instruments, coach skill inventory, and teacher needs inventory ensure consistent implementation of coaching across schools Self-identified teacher needs are used in planning and goal setting, and progress toward these goals is monitored and reflected on by coaches.

Boundaries of Coaching

A coach generally does not:

- Evaluate teachers.
- Take over during a lesson.
- Impose specific lessons or instructional strategies.
- Tutor struggling students.
- Perform the support services of an aide.

Effective Coaching Practice

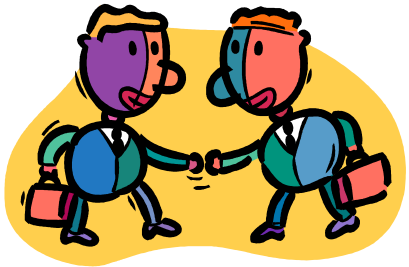


A coach should:

- Ask reflective questions
- Provide feedback and support
- Share expertise, materials, and resources
- Maintain confidentiality
- Use a coaching cycle:
  - Gather information before the lesson
  - Observe a complete lesson
  - Collect and document evidence
  - Debrief and reflect after the lesson

Complexity of Coaching

- Coaching is a collaborative process that is done with teachers, not to teachers.
- Coaching is a joint effort from both the coach and the teacher(s) involved.
- Coaching support is useful only if the teacher and coach are prepared, and willing to listen, internalize, and respond accordingly.



Time To Talk

Discuss with a neighbor:

What are ways you could measure impacts on coach and teacher knowledge?

Measuring Effects of Coaching

- Mathematics Knowledge for Teaching
- Inside the Classroom – Classroom Observation Protocol
- Student Achievement Data
- Others:
  - Teacher Survey
  - Coach and Teacher Needs Inventory
  - Reflections

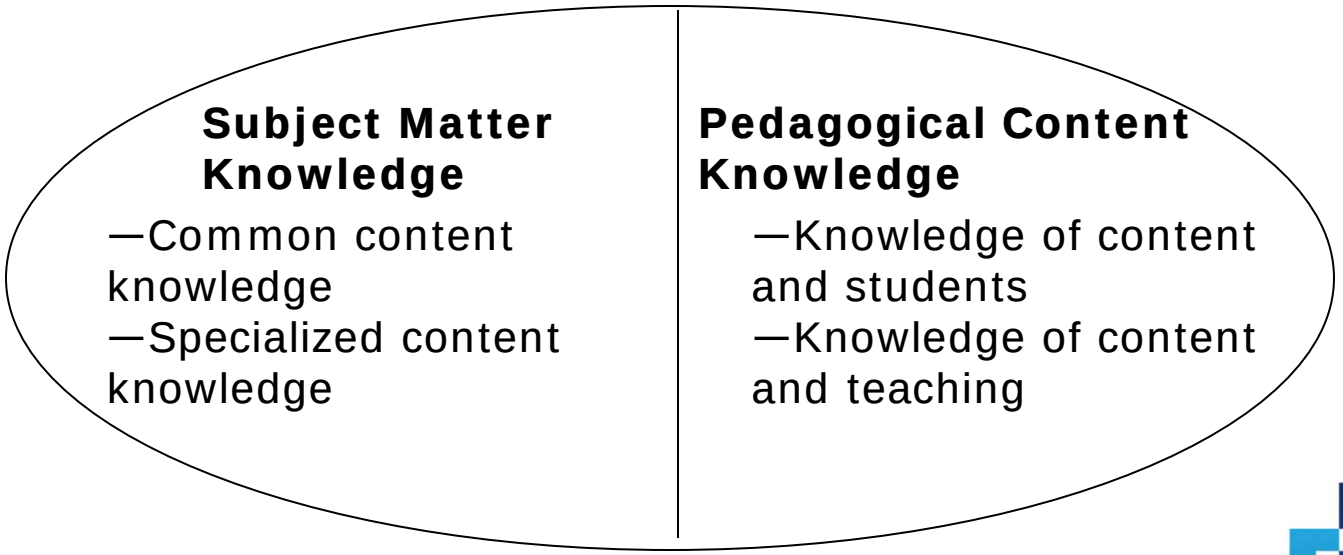
Instruments and 2010 Status √=Data in√=V and R

Instrument	Target	Purpose	Status
Mathematics Knowledge for Teaching (MKT)	Coach Teacher	assessing mathematics content knowledge for teaching	√ √
Coaching Impact Instrument (CII)	Coach Teacher	assessing coaches' and teachers' perceptions of coaching's impact on instruction	√ √
Coach and Teacher Reflection Instrument (CRI and TRI)	Coach Teacher	monitoring and logging coaching interactions including quantity, quality and duration of coaching sessions	√ √
Coaching Knowledge Survey (CKS)	Coach	assessing coaching knowledge	√
Coaching Skills Inventory (CSI)	Coach	self-assessment of coach skills	√ √
Inside the Classroom—Classroom Observation Protocol (ITC-COP)	Teacher	assessing classroom impacts	√ √
Teacher Needs Inventory (TNI)	Teacher	planning tool to provide focus for coaching sessions	√ √
Teacher Survey (TS)	Teacher	assessing teacher attitudes, beliefs and perceptions of mathematics teaching	√ √

Mathematics Knowledge for Teaching

Study of Instructional Improvement / Learning Mathematics for Teaching Project at the University of Michigan

Instrument to assess mathematics content knowledge for teaching



Mathematics Knowledge for Teaching (MKT)

- Not an assessment of individual teacher's knowledge or skill – it is a tool for looking at the impact of coaching and the coaching model in the EMC design.
- Data from MKT is used to help understand how coaching affects teaching mathematics.
- The items on the MKT are challenging – they are designed to be that way.

Mathematics Knowledge for Teaching

Design questions (e.g., quiz)

Which of these lists would be best for assessing whether students understand ordering decimal numbers.

a. 0.5 7 0.01 11.4

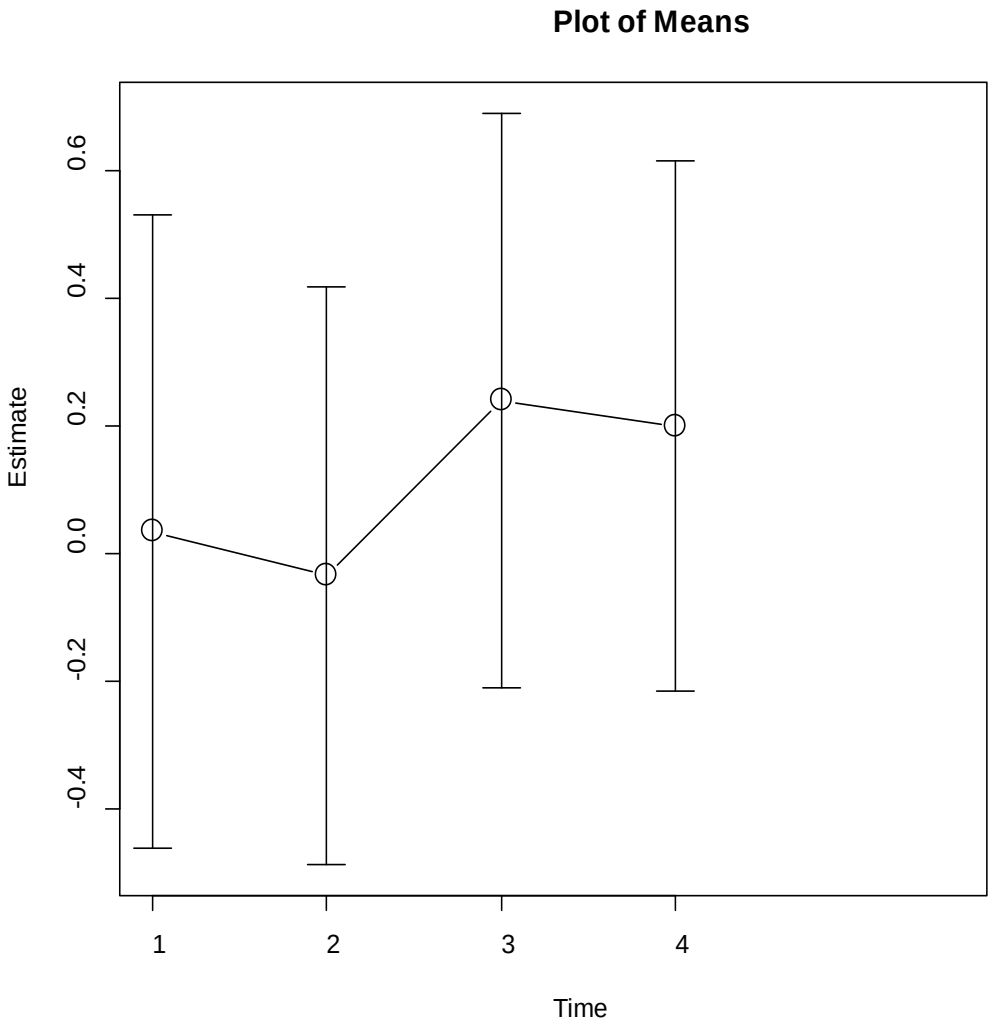
b. 0.60 2.53 3.12 0.45

c. 0.6 4.25 0.565 2.5

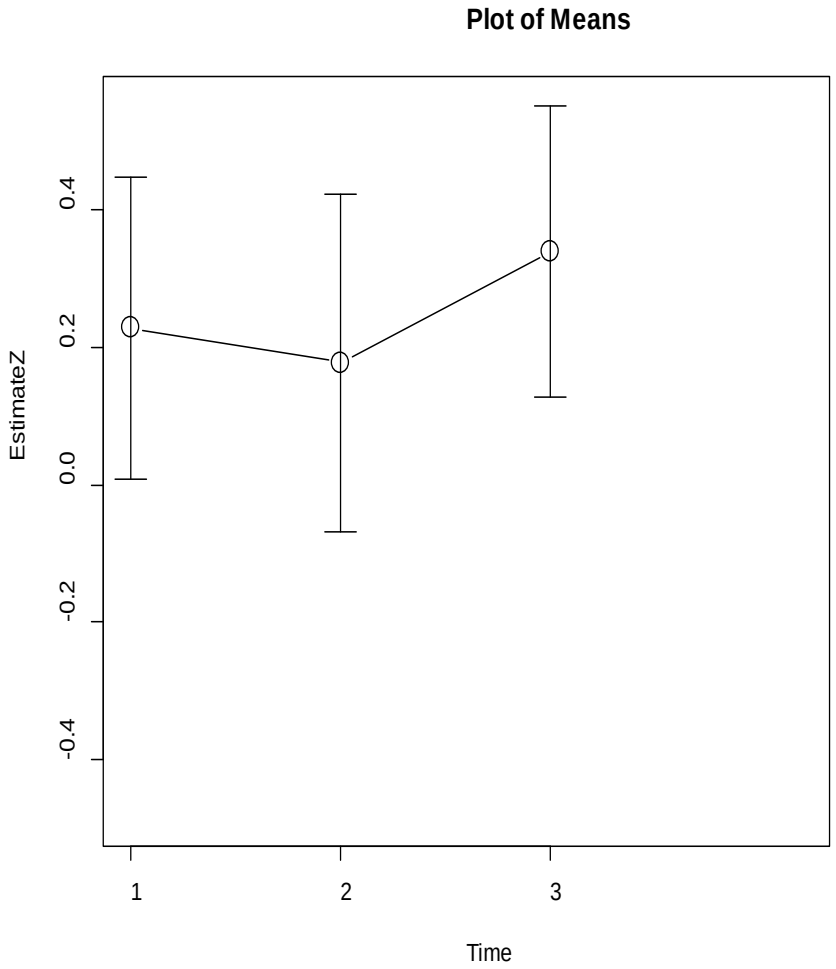
d. These lists are all equally good for assessing whether students understand how to order decimal numbers.

RELATIONSHIPS BETWEEN COACH MKT AND TEACHER MKT GROWTH

Standardized Coach MKT w/ 95% Confidence Intervals

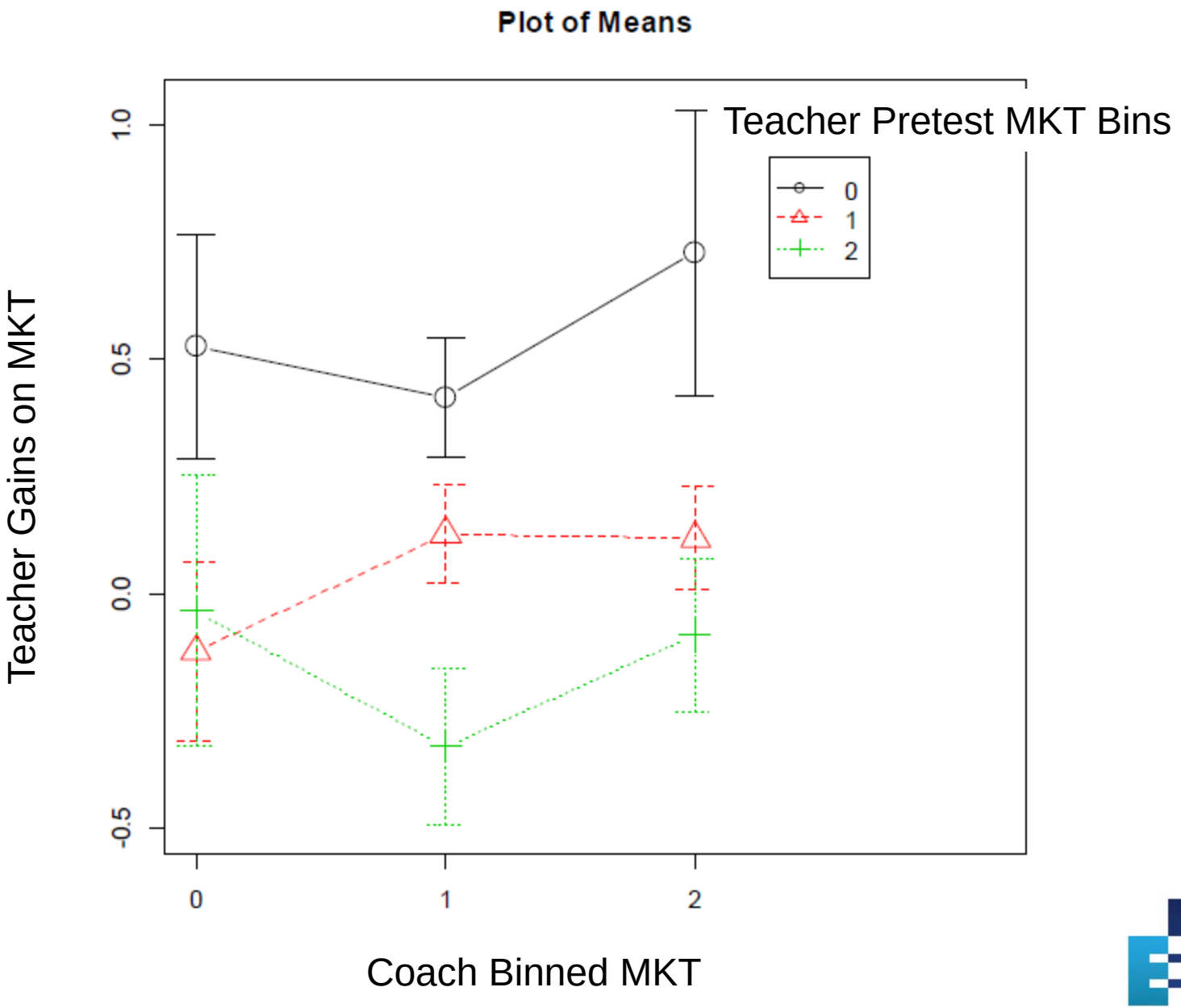


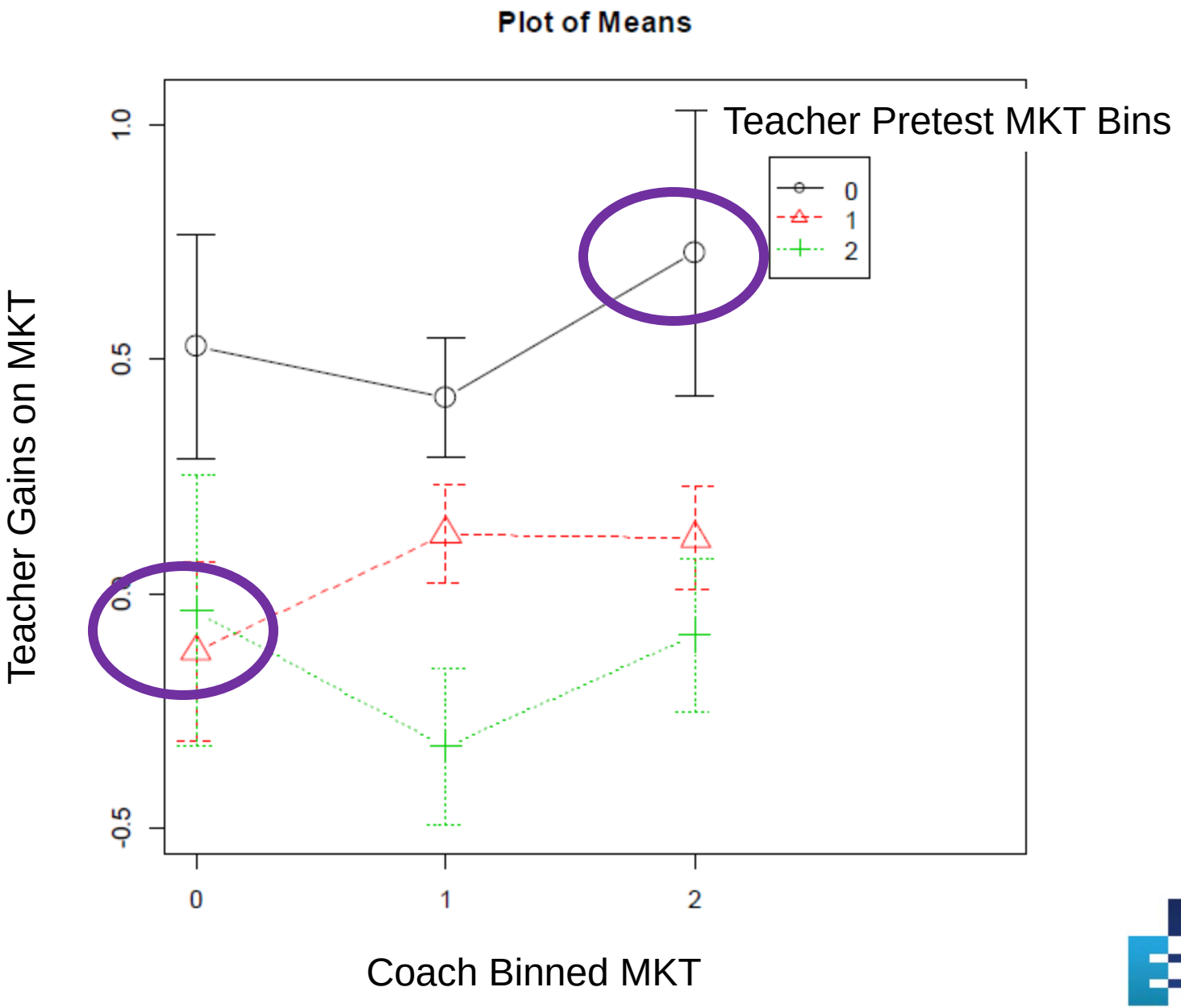
Standardized Teacher MKT w/ 95% Confidence Intervals



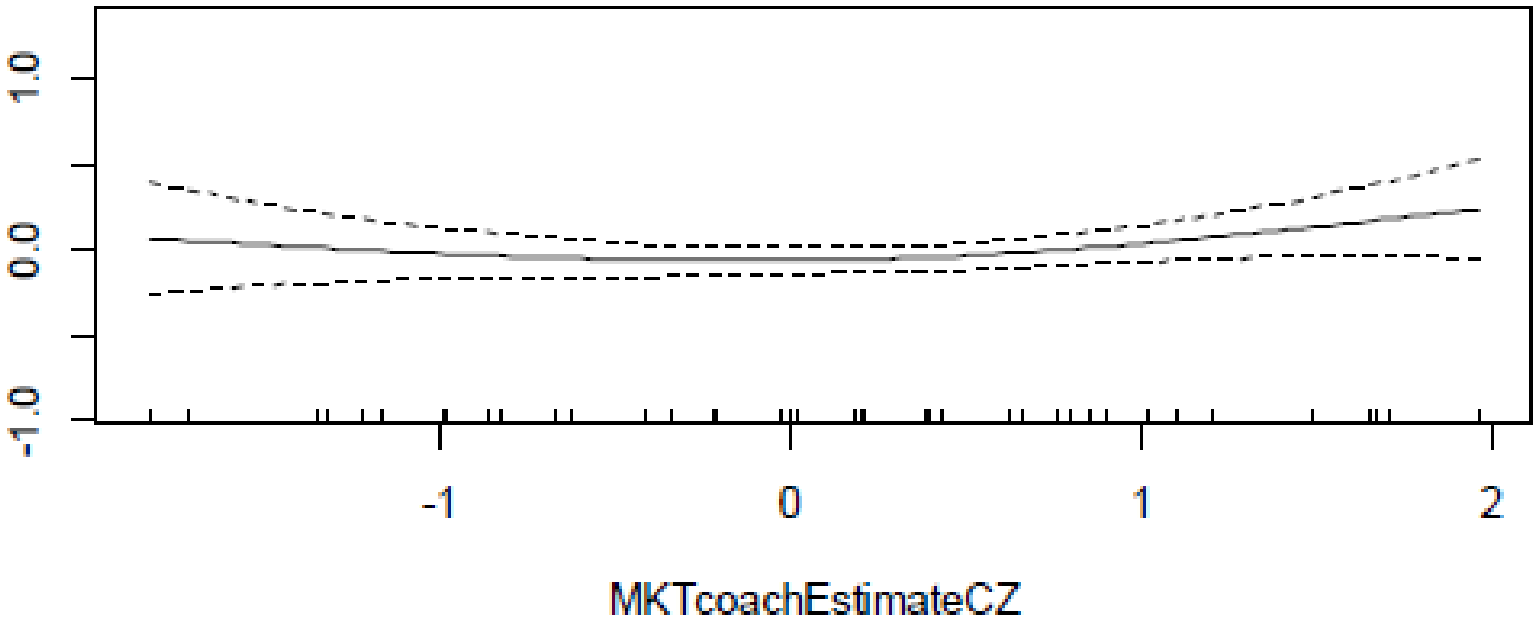
Consider coaching pairs…

- What types of coach/teacher pairs would you expect to be most effective?
- Would you expect high MKT coaches to be more effective in changing teacher MKT than low MKT coaches?
- Would this depend on the teachers MKT?
- Would the pairing of a low MKT coach with a high MKT teacher be ineffective?


Plot of Means
Teacher Pretest MKT Bins
0
1
2
Teacher Gains on MKT
1.0
0.5
0.0
-0.5
0
1
2
Coach Binned MKT


Plot of Means
Teacher Pretest MKT Bins
0
1
2
Teacher Gains on MKT
1.0
0.5
-0.5
0
1
2
Coach Binned MKT

Relationship between Coach MKT and Teacher Gains

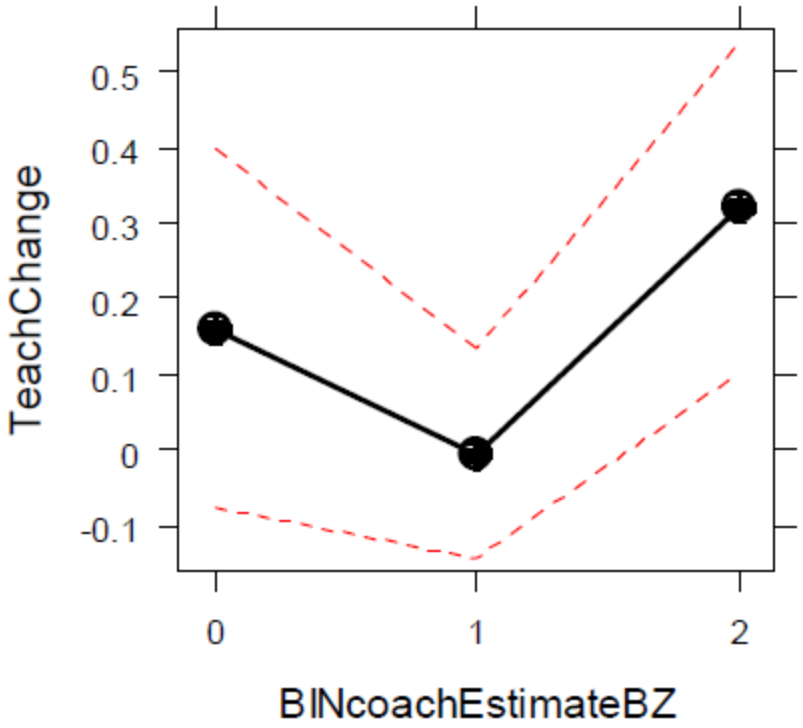


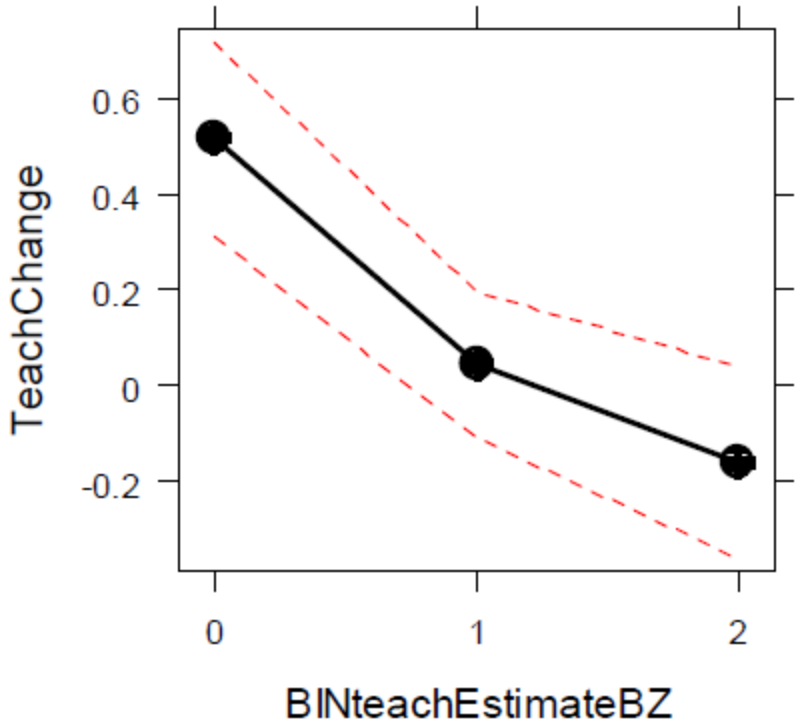
Response: TeachChange

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
BINHrs	2	0.548	0.2742	0.6703	0.5130	
BINCourses	2	1.784	0.8921	2.1812	0.1164	
MKTcoachEstimateCZ	1	0.009	0.0092	0.0225	0.8811	
EstimateBZ	1	13.617	13.6173	33.2945	4.259e-08	***
MKTcoachEstimateCZ:EstimateBZ	1	0.195	0.1952	0.4773	0.4907	
Residuals	153	62.576				

0.4090

Binned Coach and Teacher MKTs as predictors of Teacher Change





Next steps

- Control variables—intensity and quality of coaching sessions.
- Use coaching knowledge and skill assessments as explanatory variables.
- Use other measures as teacher variables
  - ITC COP
  - Efficacy

Share Your Thoughts

Discuss with your neighbor:

- What other measures would be useful in providing evidence of coaching knowledge impacting teacher knowledge?
- Given the sample size, how can we increase the impacts?

IS THERE A RELATIONSHIP BETWEEN TEACHER MATHEMATICAL KNOWLEDGE AND CLASSROOM PRACTICE?

ITC COP[1]

Ordinal rating of:

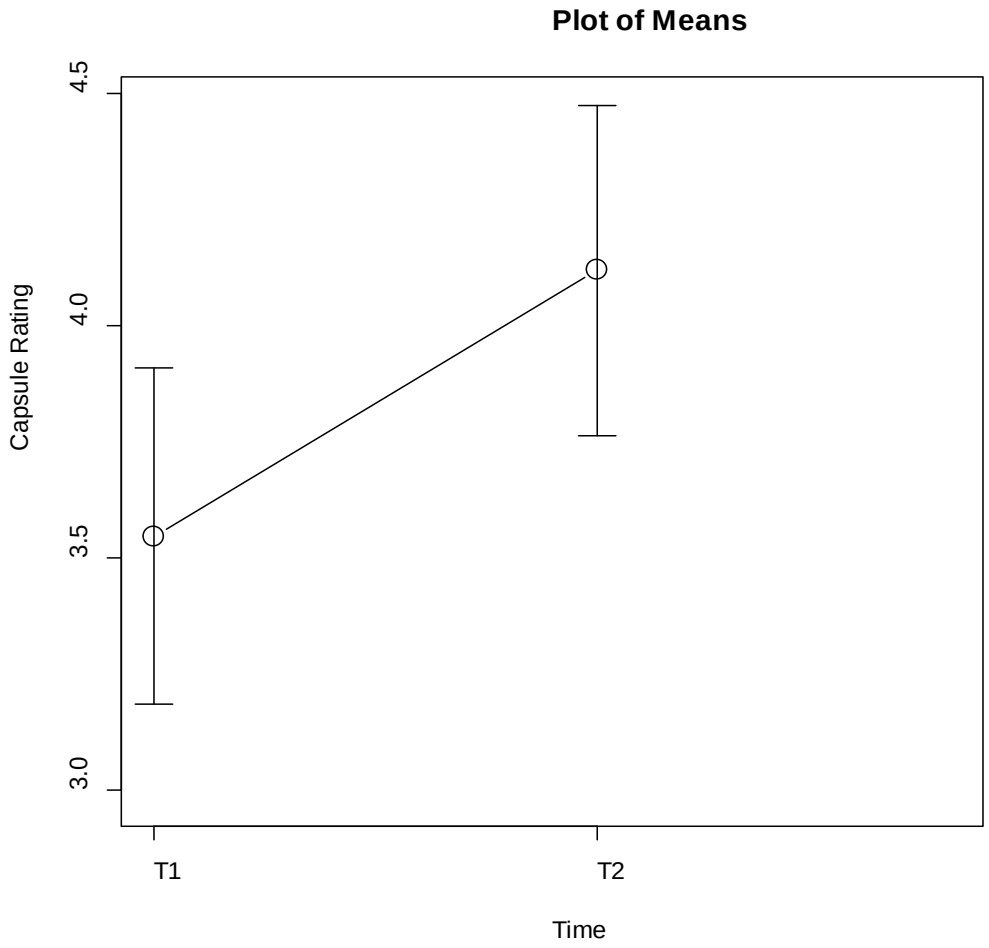
- Design
- Implementation
- Content
- Classroom Culture

Capsule

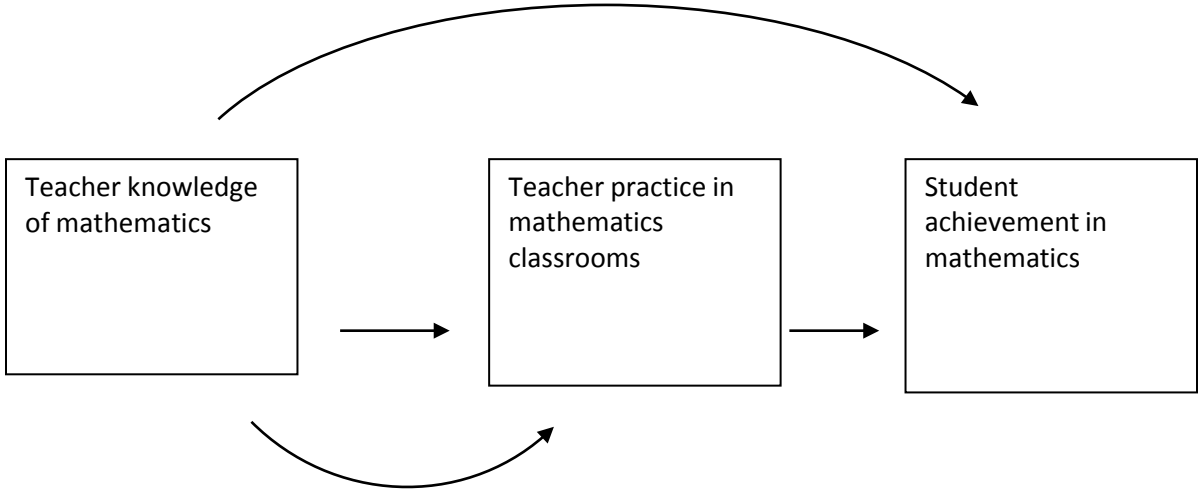
- Ineffective Instruction
  - Passive learning
  - Activity for activity sake
- Elements of Effective Instruction
- Beginning Stages of Effective Instruction (low, solid, or high)
- Accomplished, Effective Instruction
- Exemplary Instruction

[1]Horizon Research, Inc., 2000

ITC-COP Mean Capsule Ratings by Time and PD Cohort



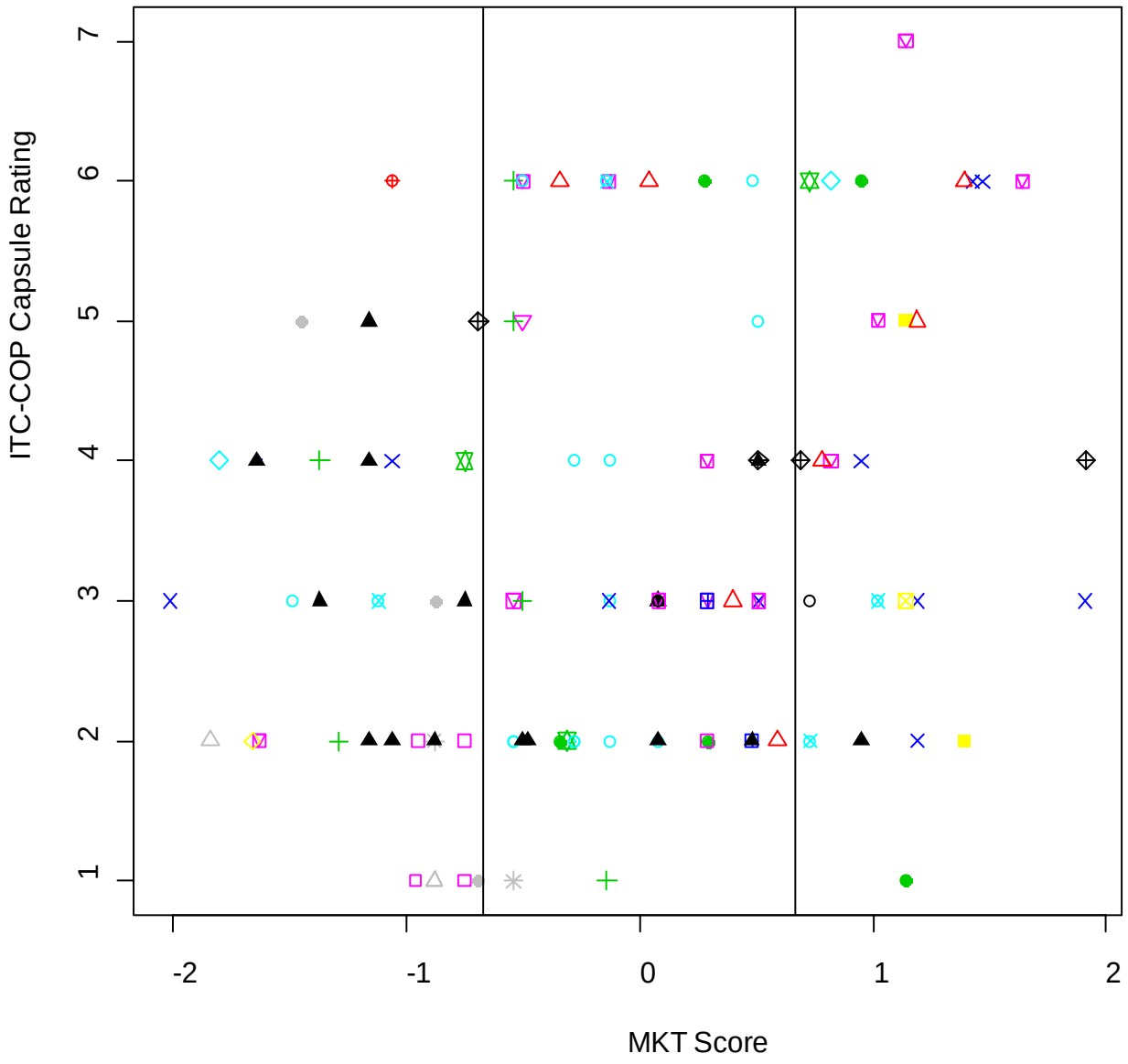
The mechanism through which we influence student achievement is through the teacher's practice.



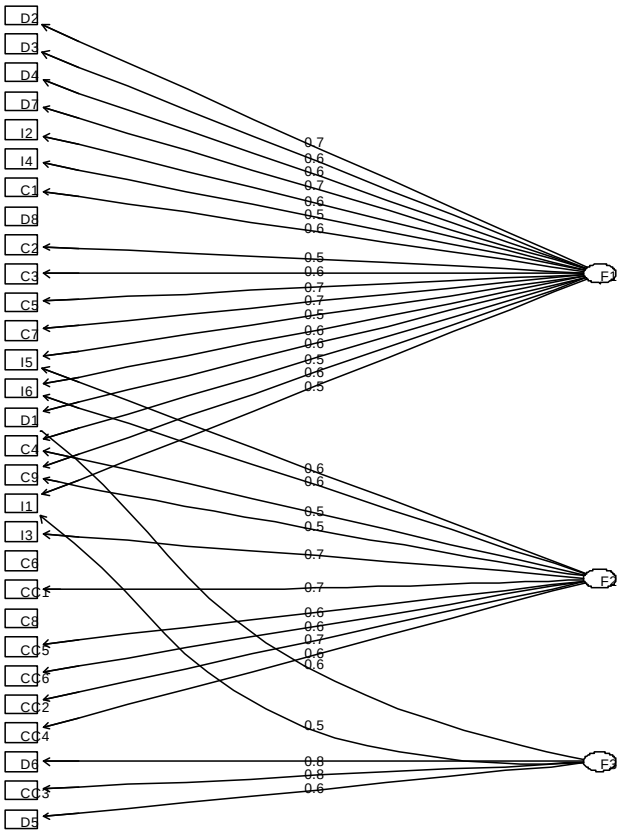
Teacher Knowledge Influences on Student Achievement

- Proxy measures such as degrees, # of mathematics courses, and intelligence have been poor predictors of student achievement

- Historically, this search has been problematic.
  - Affordance literature
  - Deficit literature
  - Hill et al. (under revision)


ITC-COP Capsule Rating
1
2
3
4
5
6
7
-2
-1
0
1
2
MKT Score

The ITC COP has 25 different items that observers use to rate what happens in the classroom. Our analysis finds that they can be grouped into 3 factors – that is, scores for the group of items tend to reflect the same underlying trait in the classroom.



Mathematics content

Student centeredness

Student collaboration

Factor 1 Mathematics Content

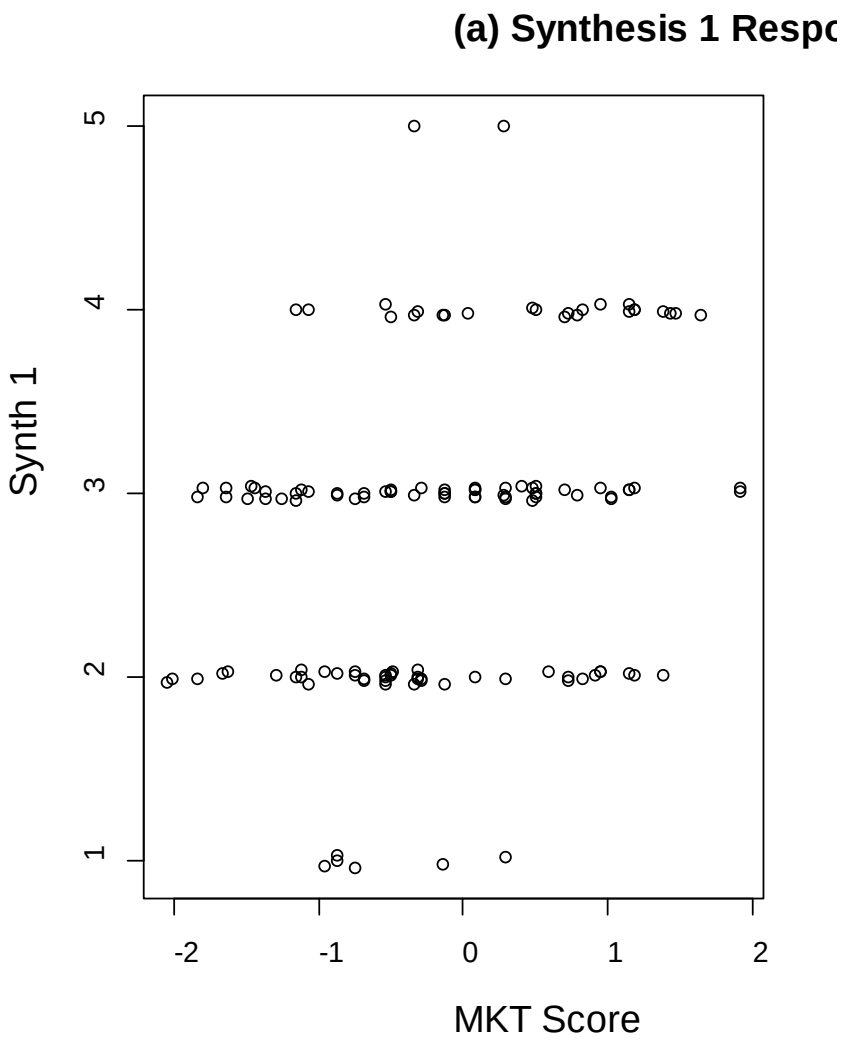
Item #	Item Description
D2	The design of the lesson reflected careful planning and organization.
D4	The resources available in this lesson contributed to accomplishing the purposes of the instruction.
D7	Adequate time and structure were provided for "sense-making."
I2	The teacher appeared confident in his/her ability to teach math.
C1	The math content was significant and worthwhile.
C2	The math content was appropriate for the developmental levels of the students in this class.
C3	Teacher-provided content information was accurate.
C5	The teacher displayed an understanding of math concepts.
C7	Elements of math abstraction were included when it was important to do so.

Factor 2 Student Centeredness

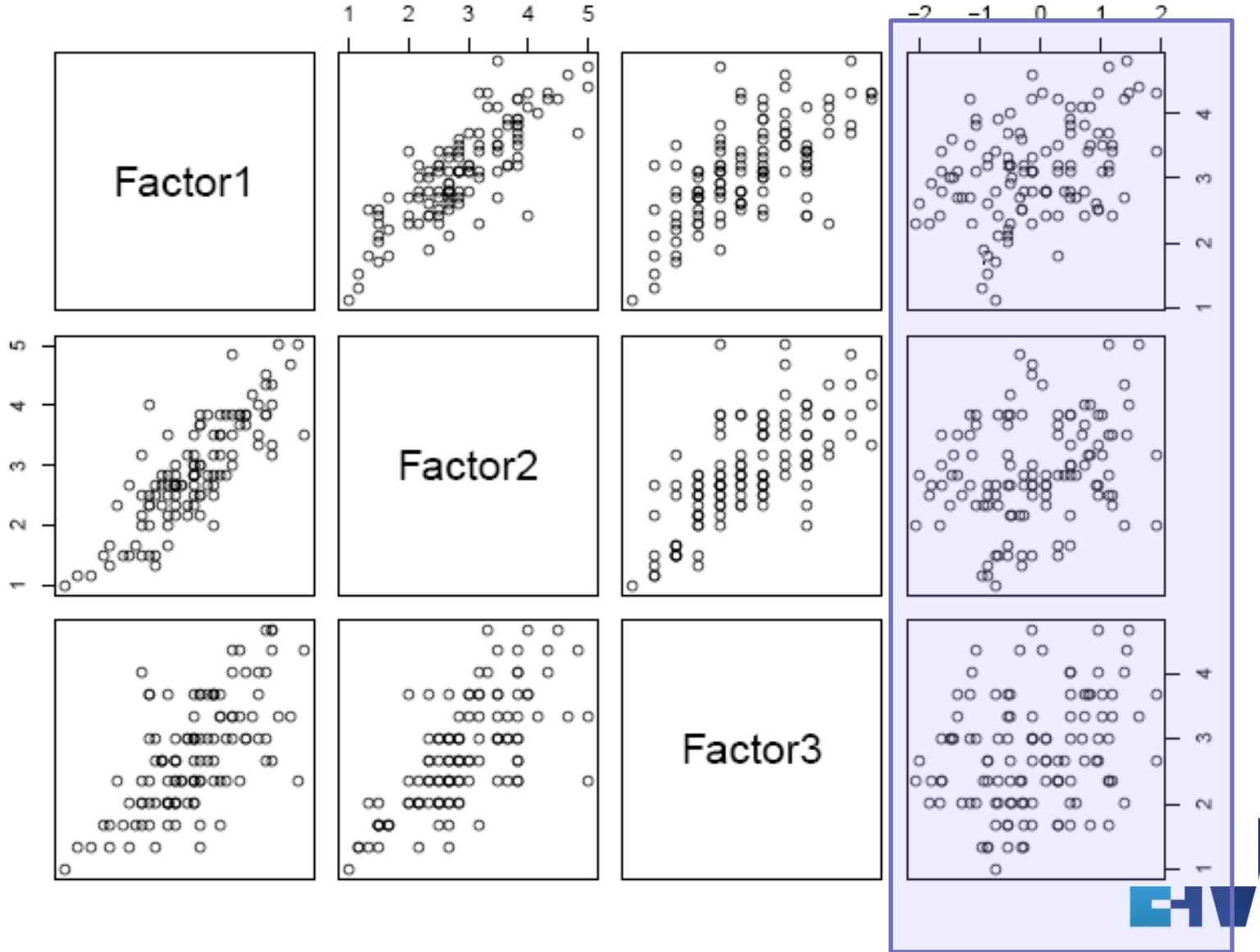
Item #	Item Description
I3	The teacher's classroom management style/strategies enhanced the quality of the lesson.
CC1	Active participation of all was encouraged and valued.
CC2	There was a climate of respect for students' ideas, questions, and contributions.
CC4	Interactions reflected collaborative working relationships between teacher and students.
CC5	The climate of the lesson encouraged students to generate ideas, questions, conjectures, and/or propositions.
CC6	Intellectual rigor, constructive criticism, and the challenging of ideas were evident.

Factor 3 Student Collaboration

Item #	Item Description
D5	The instructional strategies and activities reflected attention to issues of access, equity, and diversity for students.
D6	The design of the lesson encouraged a collaborative approach to learning among students.
CC3	Interactions reflected collegial working relationships among students.


(a) Synthesis 1 Respc
Synth 1
5
4
3
2
1
-2
-1
0
1
2
MKT Score

Teacher MKT vs. ITC COP



The Model

Linear mixed model for each of the three factor scores for teacher in district is

score $= \beta_0 + \beta_1 + \beta_2 + u + \varepsilon$.

= 1 if the teacher is in the medium MKT group and 0 otherwise, and = 1 for the high MKT group and 0 otherwise.

The Model

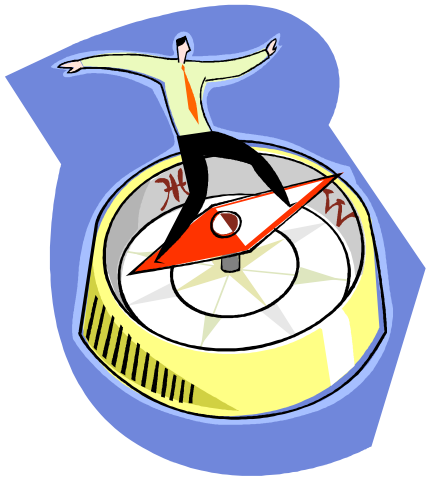
Ordinal mixed model for the response category for the teacher in the district is

$$\text{probit}[P(y_{i(k)} \quad j)] = c_j - u_k - \beta_1 M \quad - \beta_2 H$$

where $u_k \sim N(0, \ _u)$ is the random district effect, c_j are the J-1 thresholds between the categories, and and are defined as before.

Response[a]	Differences in average responses between MKT categories			LRT p-value[b]	District ICC	Pairwise comparisons, Bonferroni adjusted p-values[c]		
	M vs. L	H vs. L	H vs. M			M vs. L	H vs. L	H vs. M
Capsule	0.31	0.63	0.32	0.10	0.12	0.60	0.08	0.57
Synth1	0.48	0.70	0.22	0.05	0.25	0.17	0.05	1.00
Synth2	0.20	0.35	0.15	0.50	0.30	1.00	0.71	1.00
Synth3	0.09	0.67	0.59	0.05	0.30	1.00	0.08	0.08
Synth4	0.28	0.66	0.38	0.08	0.20	0.76	0.07	0.41
Factor1	0.20	0.47	0.27	0.02	0.33	0.44	0.01	0.19
Factor2	0.12	0.42	0.30	0.08	0.32	1.00	0.09	0.25
Factor3	0.15	0.52	0.37	0.03	0.32	1.00	0.03	0.12

What Change?

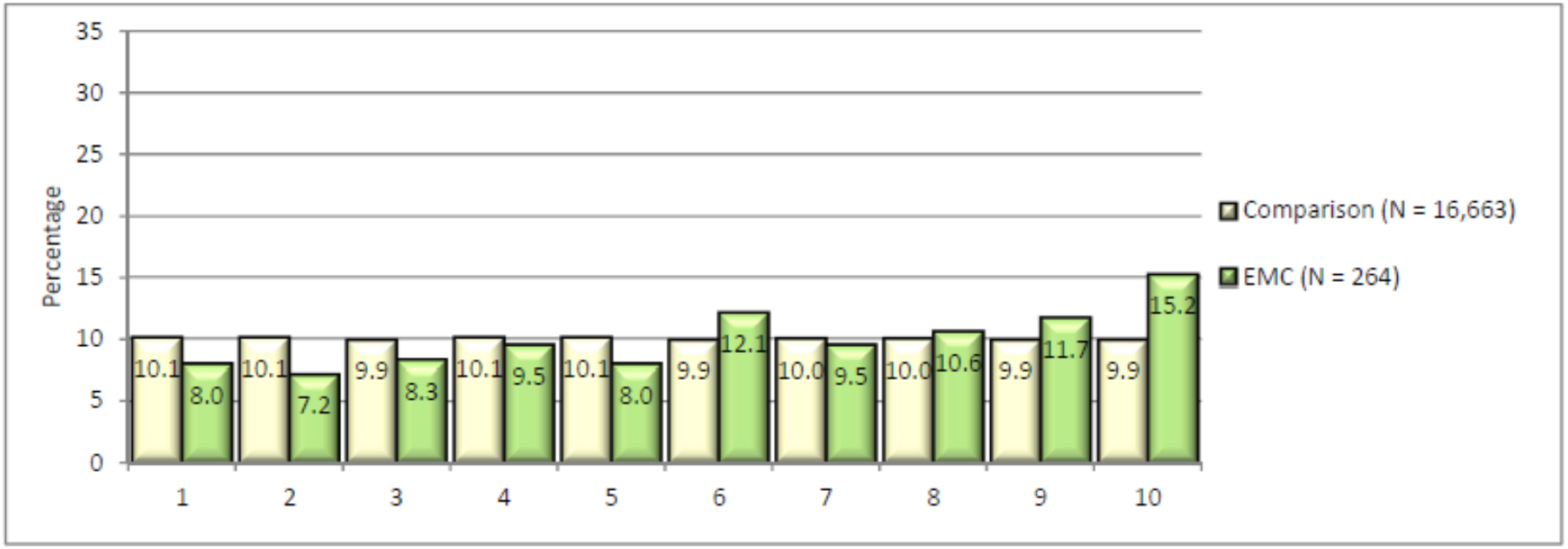


Discuss with a neighbor:

What change would provide additional data to support impacts on practice?

Effects on Student Achievement

EXHIBIT 5. BINNED RESULTS FOR PARTICIPANT TEACHER STUDENTS AND COMPARISON TEACHER STUDENTS



This Exhibit suggests that students of teachers working with coaches participating in EMC grew more on the ISAT from 2009 to 2010 than did other similar students during the same time period. This was particularly true for the students at the highest bin levels.

Effects on Student Achievement

EXHIBIT 6. BINNED FOURTH GRADE RESULTS FOR PARTICIPANT TEACHER STUDENTS AND COMPARISON TEACHER STUDENTS

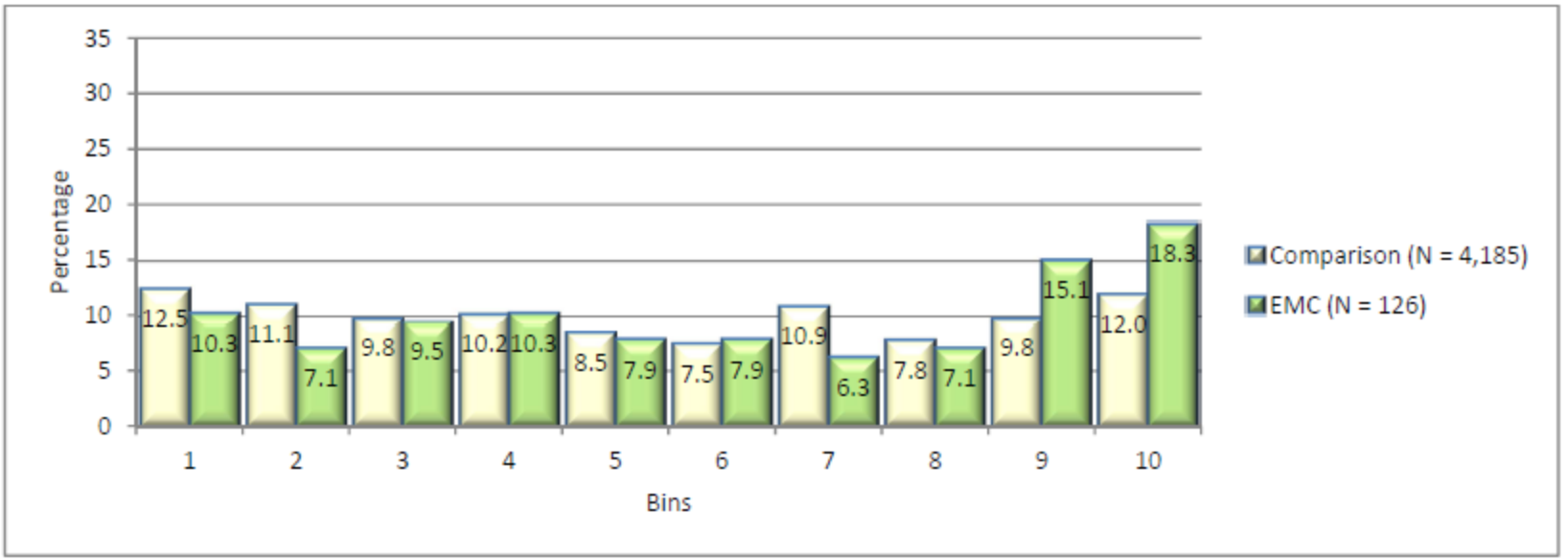


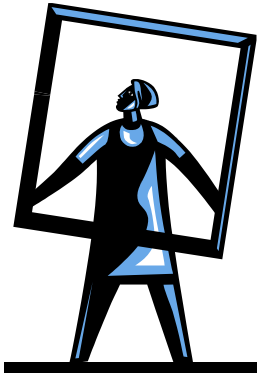
Exhibit 6 revels that students of teachers working with coaches in the EMC project scored higher than other students in the same school districts in bins 9 and 10, where the highest gains were made from third grade to fourth grade.

Effects of Student Achievement

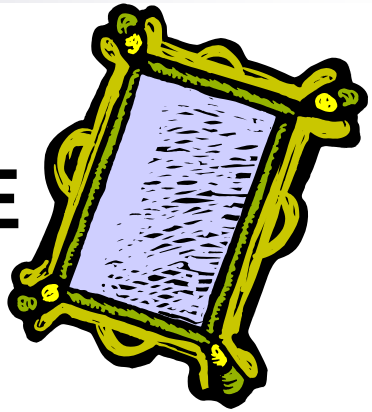
- Results should be interpreted with some caution because there were only 43 students of participating teachers in this analysis.
- Overall, students of teachers who worked with coaches participating in the EMC project increased their test scores slightly more than students of other teachers who did not work with coaches.

Effects of Student Achievement

- Exploratory analyses revealed that there is considerable variation between districts, between coaches, and between classrooms, which should be accounted for in further analyses using hierarchical linear modeling (HLM).



Framing the Picture



- Evidence at this time provides snapshots
- The full story will emerge over next two years
- Thanks for your insights.

Research and Impacts in K8 Mathematics Coaching

Articles

-

(NCSM Journal Fall 2011)

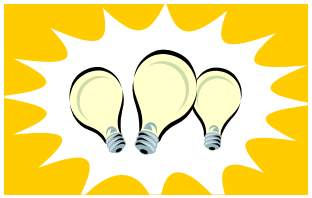
-

(Journal of Staff Development, February 2011)

Questions ???

Ideas

Comments



EMC
EXAMINING
MATHEMATICS
COACHING

Contact Information:

Email: emc@math.montana.edu
Web: www.math.montana.edu/~emc/