Research in Grades K-8 Mathematics Classroom Coaching

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EXAMINING MATHEMATICS COACHING

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EMC Project Description

EMC is a 5-year research and development project examining the effects of a coach's *knowledge for coaching* on a diverse population of K-8 teachers.

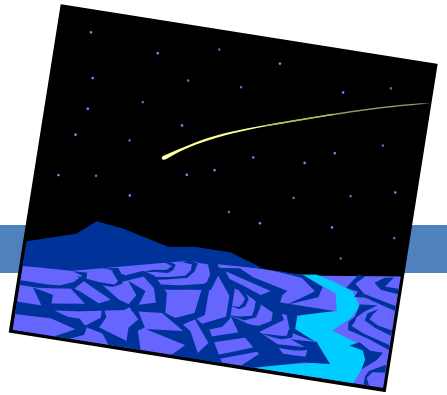
Mathematics Classroom Coaching

- A recent development in mathematics professional development for practicing teachers.
- Built on a foundation of coaching in other professions, like business and medicine.
- Used by school districts nationwide and encouraged by National Mathematics Advisory Panel (2008).
- There are a variety of educational coaching models coaches might follow.

Mathematics Coach: EMC Definition

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 include the **why, what, and how** of teaching mathematics.

Impacts of this Study



- Understanding of **knowledge** needed for effective mathematics coaching.
- Understanding of what **practices** contribute to effective mathematics coaching.
- **Instruments** to evaluate and monitor mathematics coaching

How Coaching Works

- A school district or school principal identifies an individual to serve as a classroom coach.
- That coach might be a classroom teacher, a former classroom teacher, a university faculty member, or a principal.
- The coach and teacher work throughout the school year within *coaching cycles* to improve that teacher's classroom practice.

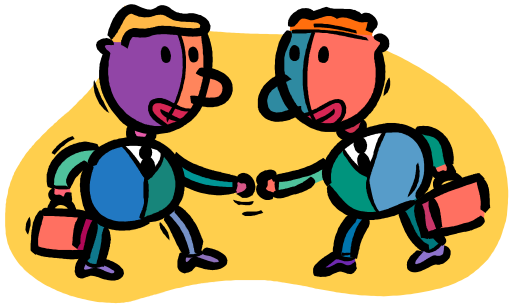
Coaching Cycle for EMC Project

There are three distinct parts to each coaching cycle designed to examine mathematics instruction.

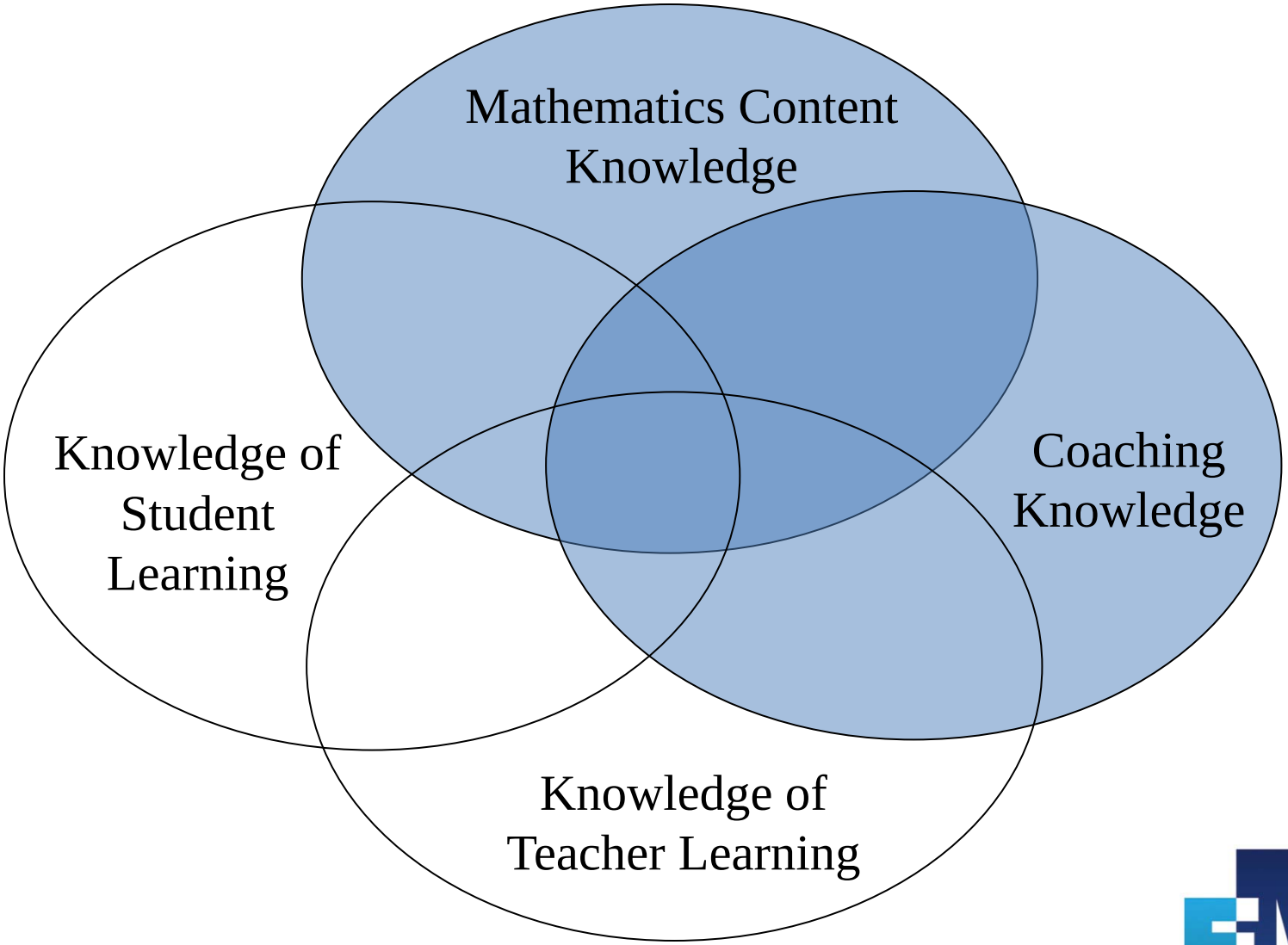
- Pre-Lesson Conference (~15 minutes)
- Lesson Observation (entire class period)
- Post-Lesson Conference (~30 minutes)

EMC Research Hypothesis

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



Knowledge Domains



Research design

- A **non-experimental** design will answer: To what extent does a coach's **depth of content knowledge** in coaching knowledge and mathematics content knowledge correlate to **coaching effectiveness**?

Research design

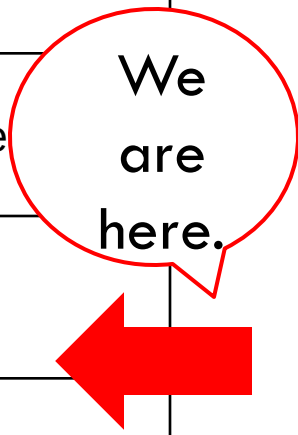
- A **non-experimental** design will answer: To what extent does a coach's **depth of content knowledge** in coaching knowledge and mathematics content knowledge correlate to **coaching effectiveness**?
- An **experimental** design randomly assigns coaches to one of two groups to answer: To what extent does professional development targeting these two knowledge domains **improve coaching effectiveness**? and To what extent are the effects of the targeted professional development **explained by increases in knowledge**?

Research Design

- Each coach (n=56) is randomly assigned to Group 1 or Group 2
- Group 1 coaches have mathematics content PD (summer 2010), followed two summers later by coaching knowledge PD (summer 2012)
- Group 2 coaches have coaching knowledge PD (summer 2011), followed two summers later by mathematics content PD (summer 2013).

Crossover Design

	Group 1	Group 2
Year 1 2009-10	Provide orientation to EMC coaching model	
Year 2 2010-11	Mathematics Content Knowledge	
Year 3 2011-12		Coaching Knowledge
Year 4 2012-13	Coaching Knowledge	
Year 5 2013-14		Mathematics Content Knowledge



Project Variables and Measures

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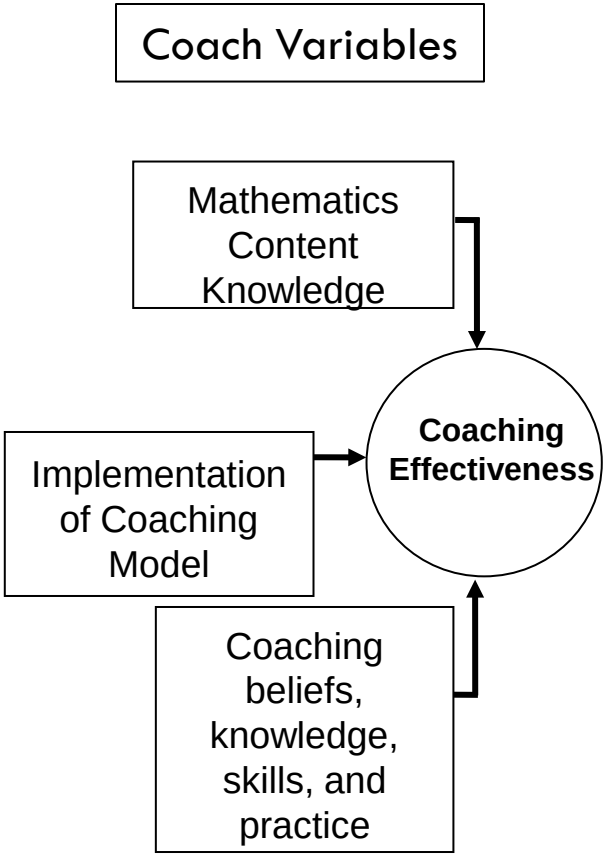

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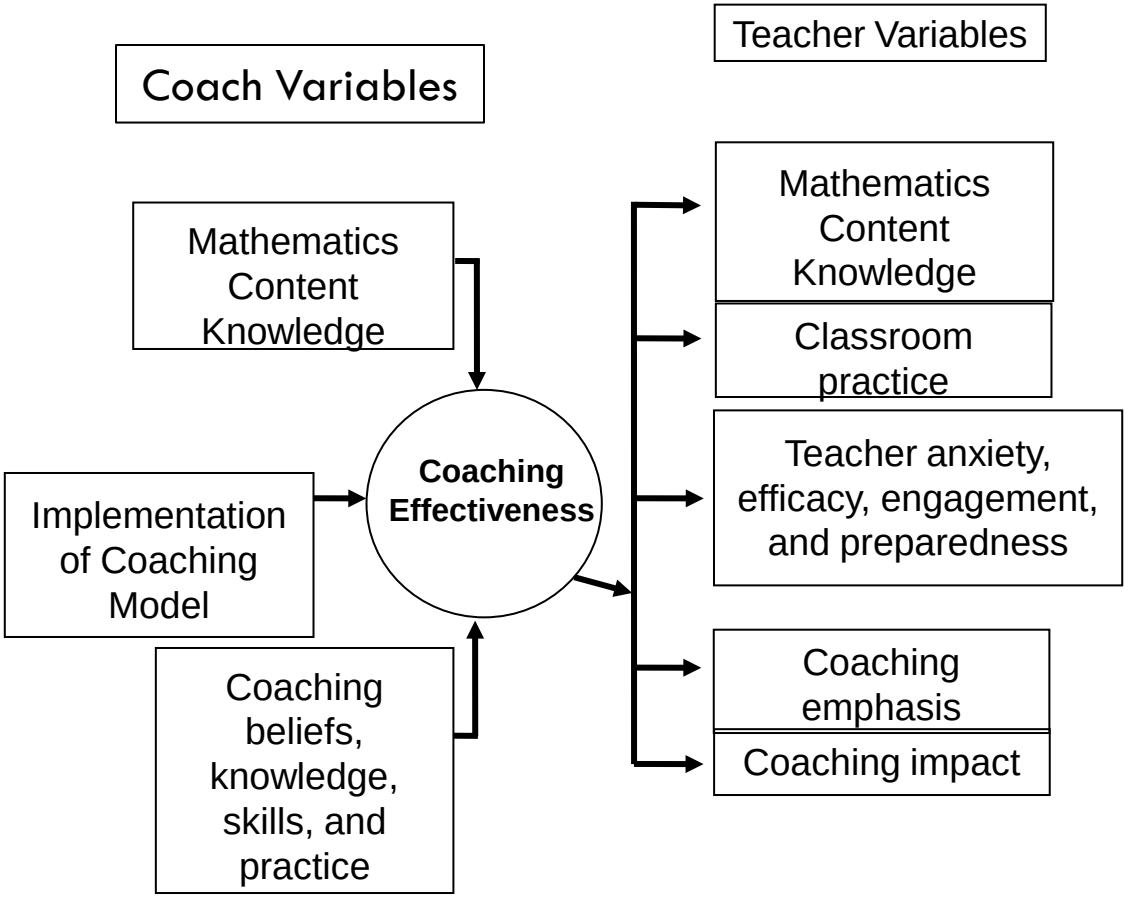

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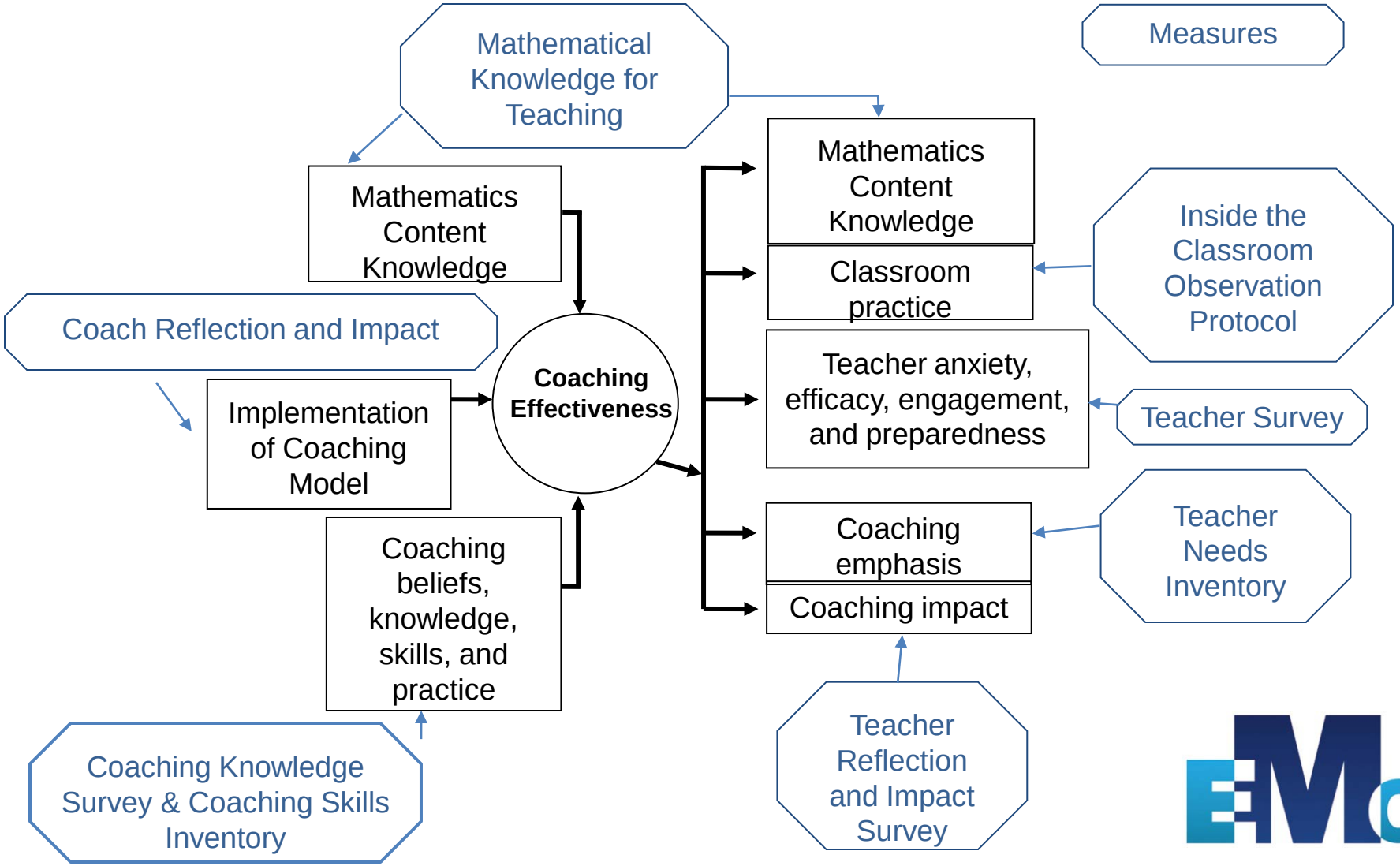
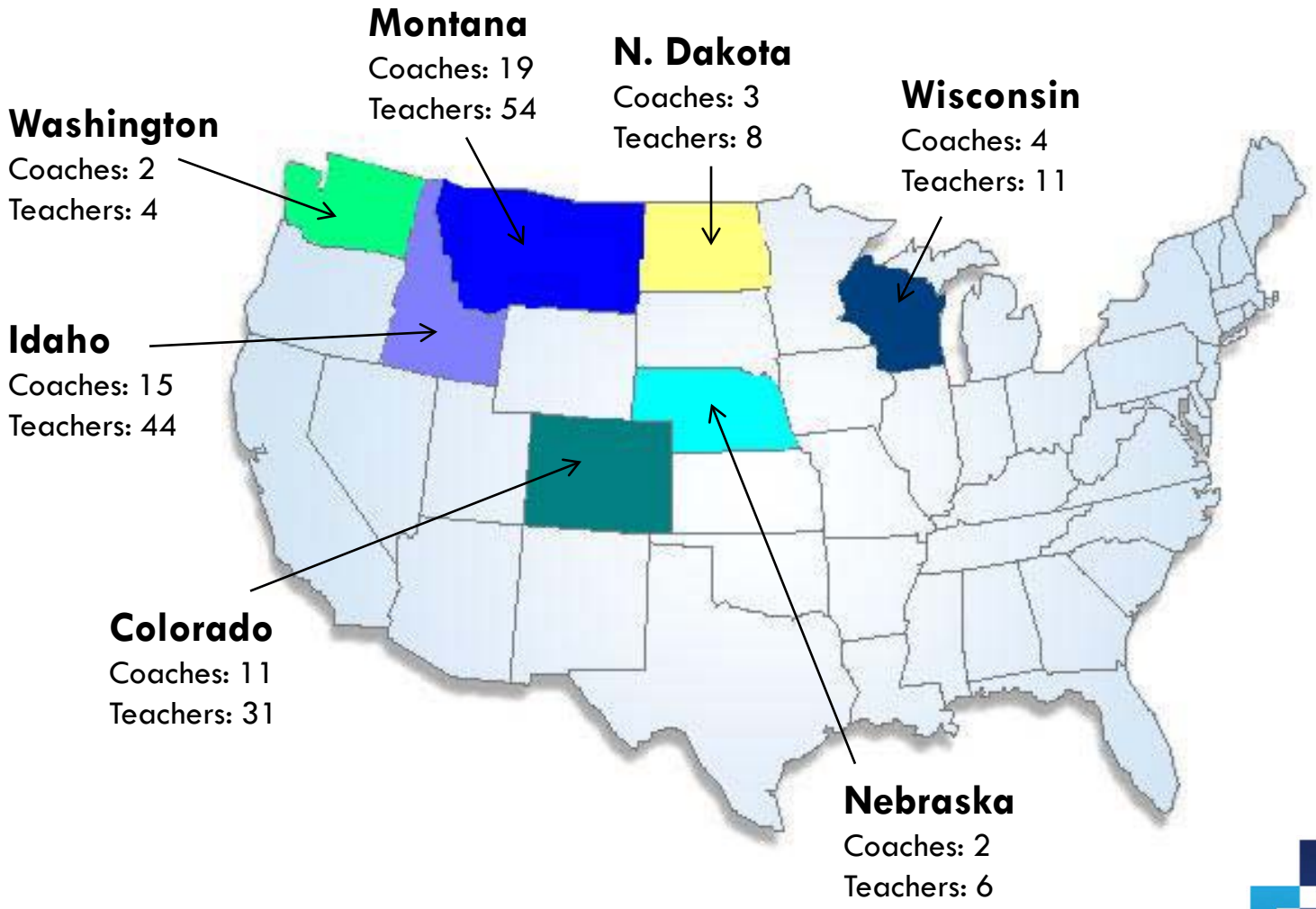


Coaching Model

Coaching Model	•**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 eight times per academic year and at least four 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

EMC Participants: Where they are



What makes a knowledgeable coach?

Early research result

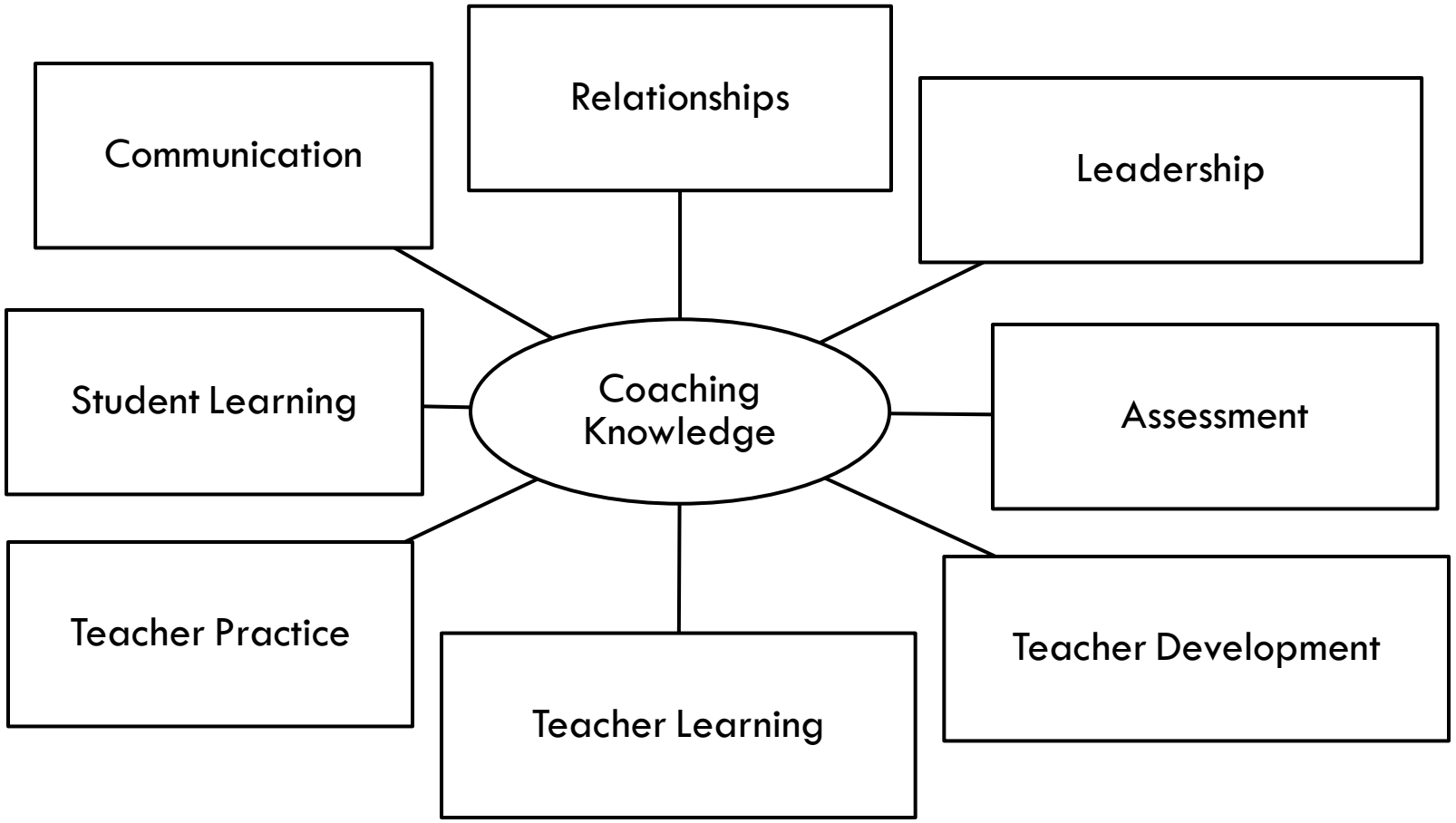
Defining Coaching Knowledge

- Three-phase Delphi process in 2009 engaged 10 national experts and practitioners in the area of mathematics coaching.
- The Delphi panel identified 8 components of coaching knowledge.
- Experts collectively defined each knowledge area and expressed their level of agreement with the collective definitions.

Asking Experts

- Panelists responded to an open-ended question to define what coaching knowledge effective instructional coaches hold, as distinct from effective teachers.
- We used qualitative methods to identify domains of knowledge.

Domains: Coaches Know About



Establishing Definitions

Phase 2

- Panelists were asked to define each of seven knowledge domains.
- Researchers used these data to create definitions in each knowledge area.

Phase 3

- Panelists rated their agreement for each definition.
- Though panelist came from different perspectives on coaching, we reached a high level of agreement.

Teacher Learning and Teacher Development

Teacher Learning

- Engaging teachers in the coaching process
- How teachers in general acquire knowledge of content, pedagogy, and pedagogical content
- How individual teachers best acquire knowledge
- The discrepancy between "vision and practice"

Teacher Development

- Teacher development in content, pedagogy, beliefs, and management
- How to support individual teachers' development
- Teachers' motivations and barriers for learning

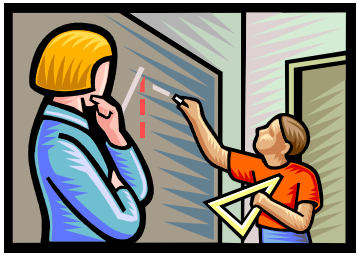
Student Learning and Teacher Practice

Student Learning

- How to support teachers in applying mathematical processes (discourse, exploration, engagement) to classrooms.
- How to help teachers manage the learning environment and improve student learning.

Teacher Practice

- How to discern teacher beliefs.
- Holds a depth and breadth of knowledge of teaching research and teaching actions.



Assessment and Communication

Assessment

- Assess teacher needs and using that assessment to set goals for coaching
- Assess student thinking and using that to set goals for coaching
- Help the teachers know how to use assessment in their classrooms

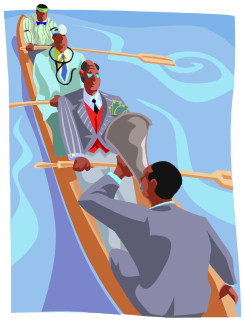
Communication

- Communicate professionally about students, curriculum, and classroom practice.
- Mediate a conversation, by pausing, paraphrasing, probing, inquiring, and asking reflective questions.
- Use nonverbal communication and listen actively
- Communicate in problem-resolving conversations

Relationships and Leadership

Relationships

- The purpose of the relationship is to support teaching and content
- Communicate in a way that establishes trust, rapport, and credibility
- Establish positive inter-personal environments
- Foster relationships that respect various cultural influences (socio-cultural, school/district, and authority-autonomy)



Leadership

- Be strategic about setting goals and objectives for teachers and students
- Use, evaluate and influence the school's vision
- Evaluate the utility of educational policies
- How to address challenges
- The coaching process

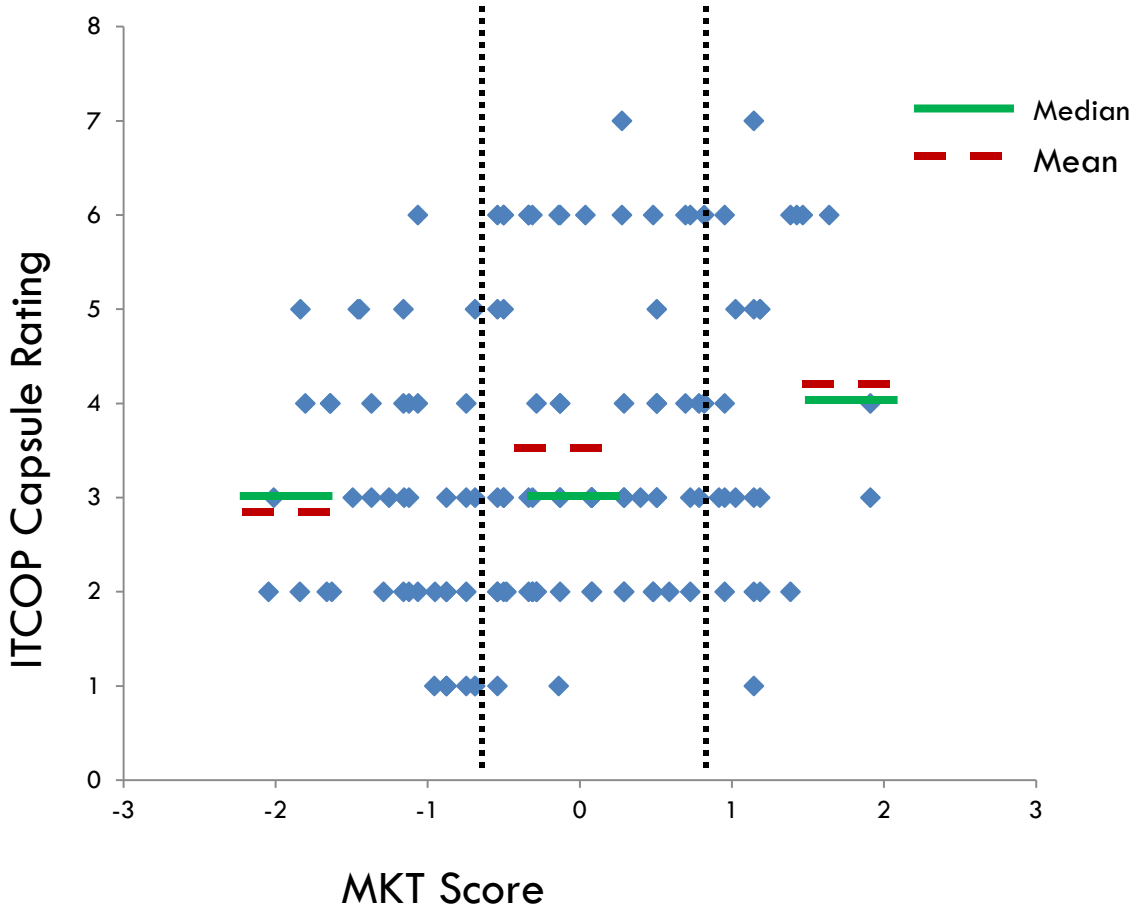
Classroom practice and teacher mathematical knowledge

An early research result

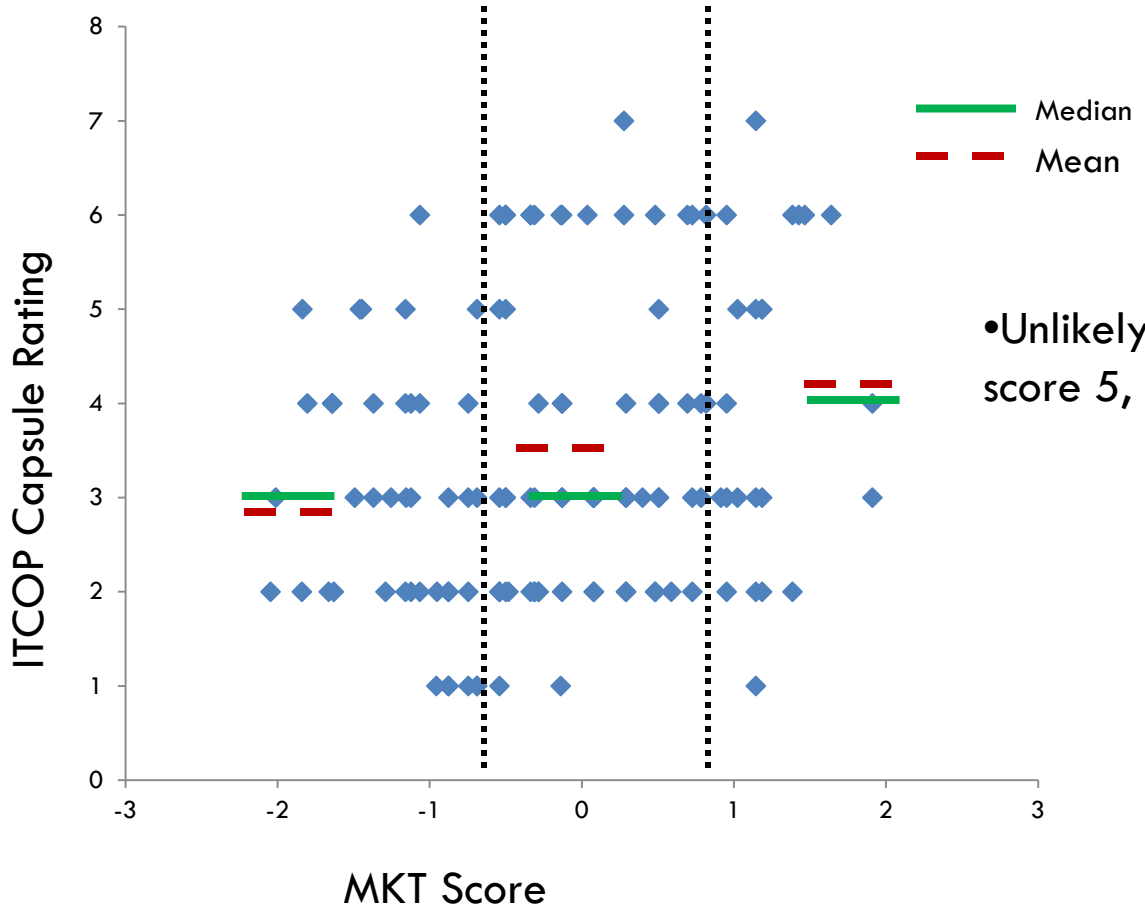
Measures of Effectiveness

- MKT is a widely-used measure of a teacher's *mathematical knowledge for teaching*.
- *Inside the Classroom Observation Protocol* measures how likely a teacher's instruction is to promote student understanding of mathematics
- MKT is easy to administer; ITCOP is expensive and time consuming. Is it important to use both measures?

MKT vs ITCOP

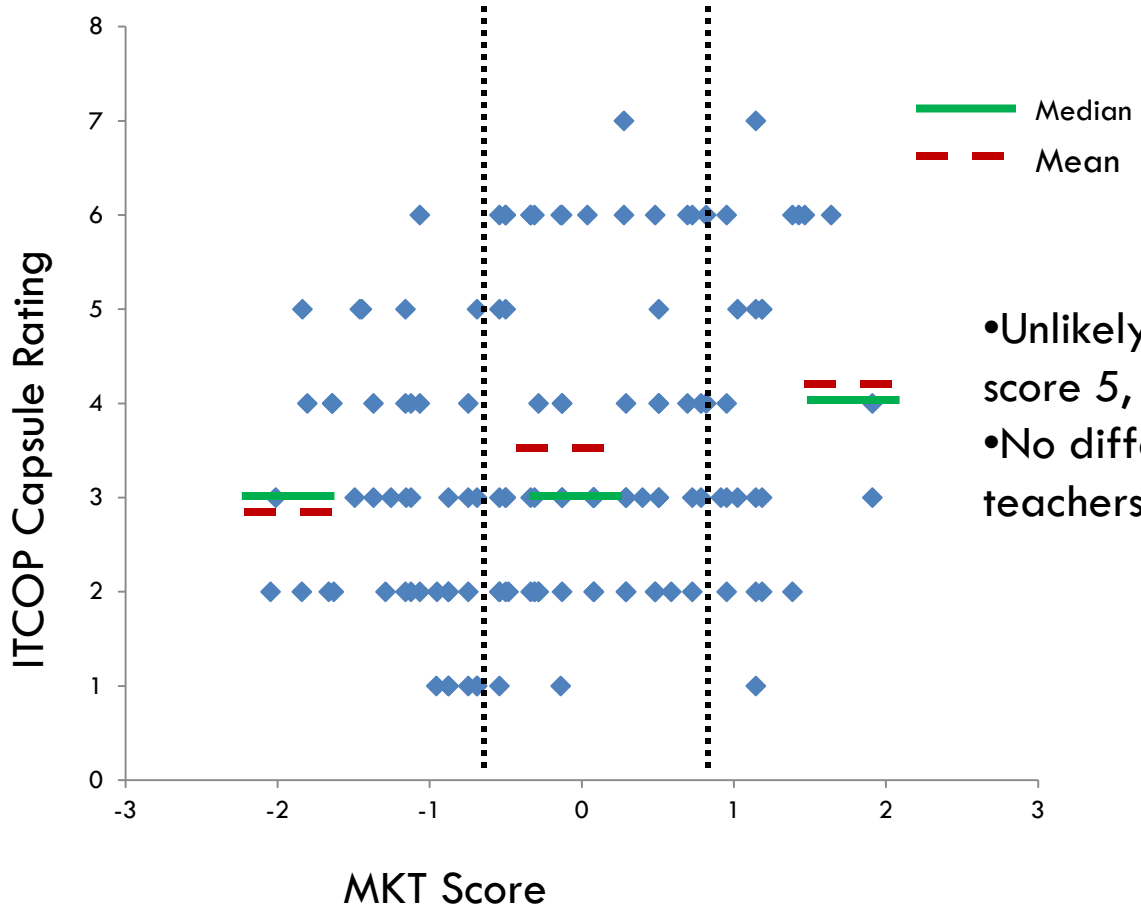

ITCOP Capsule Rating
MKT Score
Median
Mean
0
1
2
3
4
5
6
7
8
-3
-2
-1
0
1
2
3

MKT vs ITCOP



- Unlikely that teachers binned as low MKT score 5, 6, or 7 in classroom practice.

MKT vs ITCOP



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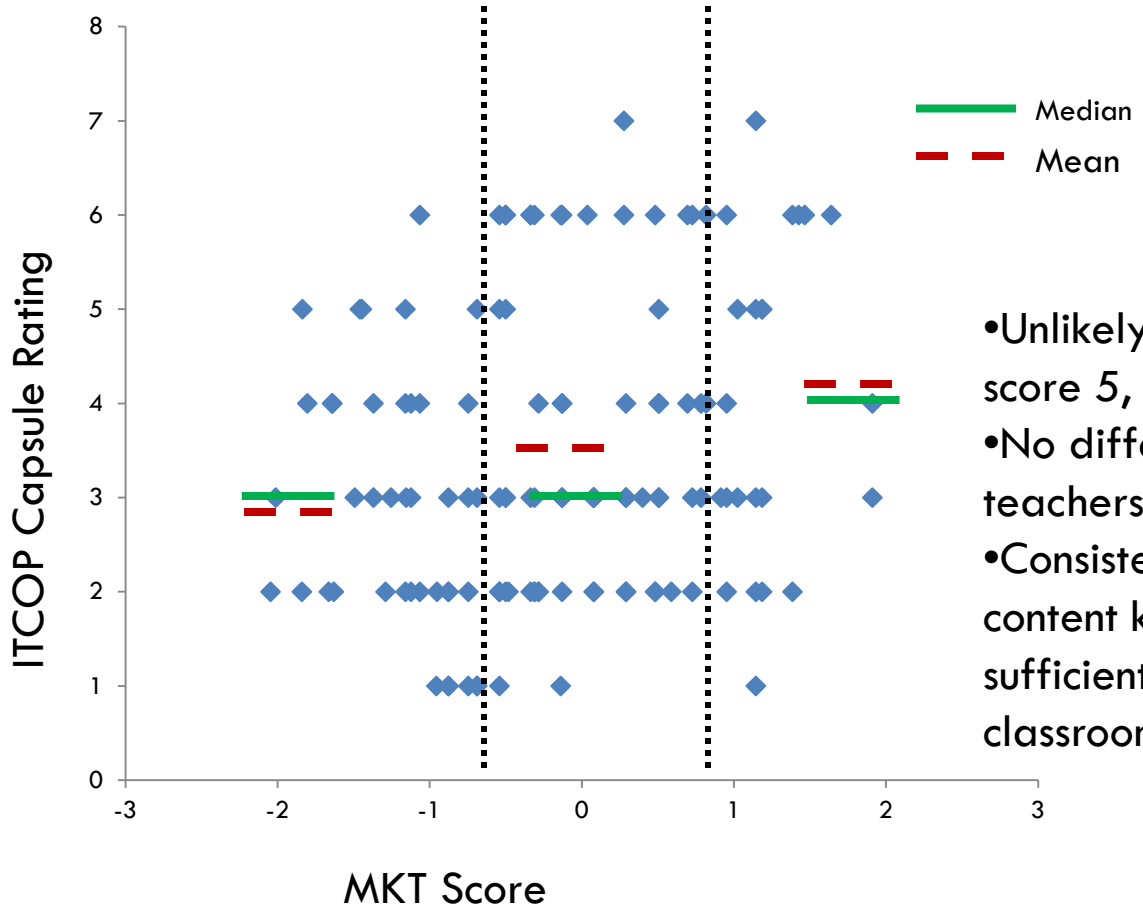
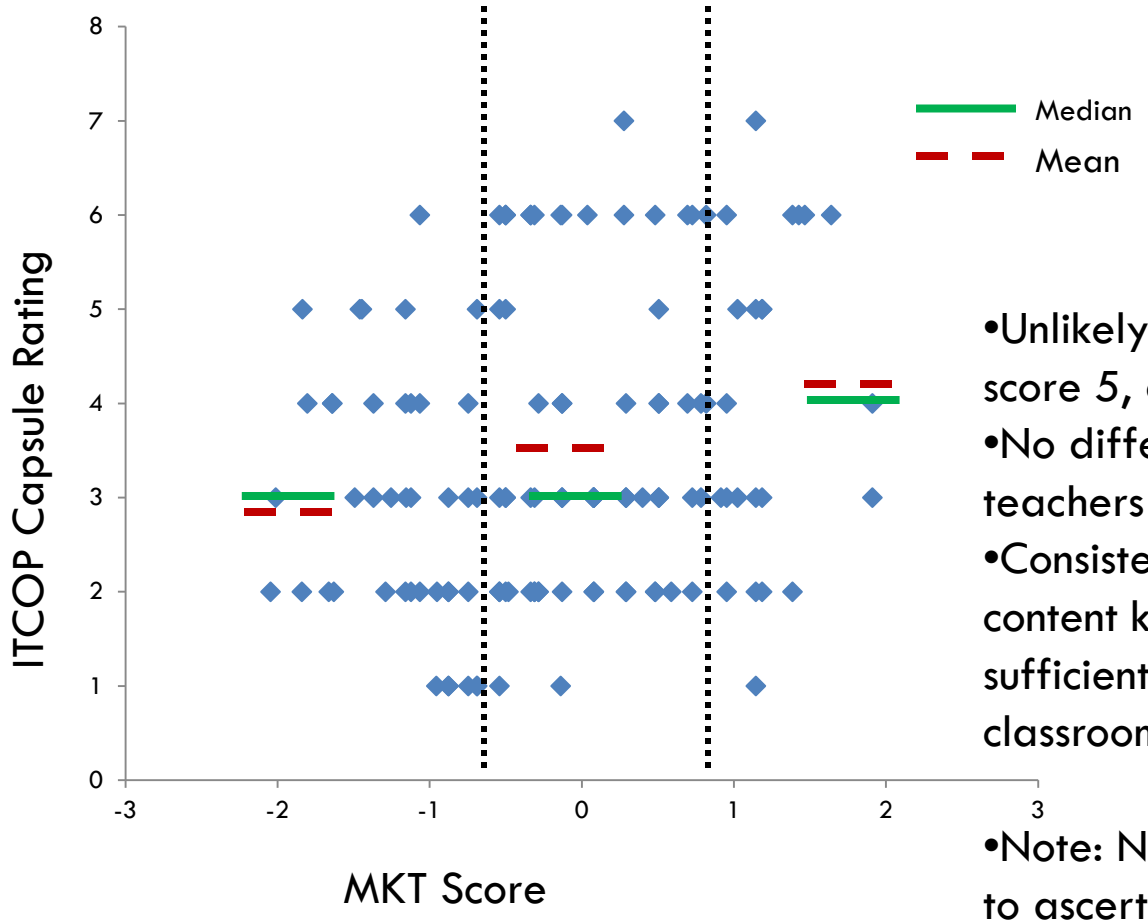
- No difference in median ITC scores for teachers in the low and mid MKT bins.

MKT vs ITCOP



- Unlikely that teachers binned as low MKT score 5, 6, or 7 in classroom practice
- No difference in median ITC scores for teachers in the low and mid MKT bins
- Consistent with the theory that mathematical content knowledge is a necessary, but not sufficient, condition for standards-based classroom practice.

MKT vs ITCOP



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- Consistent with the theory that mathematical content knowledge is a necessary, but not sufficient, condition for standards-based classroom practice.

- Note: No studies have had sufficient power to ascertain whether high ITCOP is associated with higher student outcomes.

Coaching Knowledge PD

Professional Development Challenge

- Create two distinct one-week professional development courses
- One course should shift participants' knowledge of **mathematics content,** specifically in the area of number and operation, with a focus on ratio and proportion
- One course should shift participants' **coaching knowledge,** as described by coaching authors, addressing eight themes identified by coaching experts

Coaching Knowledge Topics

Monday	Tuesday	Wednesday	Thursday	Friday
Teacher Learning	Student Learning & Teacher Practices I	Communication for Coaching	Teacher Practices & Student Learning, II	Logistics of Coaching
Themes: Teacher Development and Teacher Learning	Themes: Teacher Practice and Student Learning	Themes: Communication and Assessment	Themes: Teacher Practice and Student Learning	Themes: Relationships and Leadership

Week-long Theme

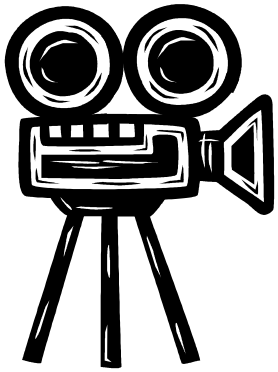
- Teaching coaches to recognize standards-based mathematics

- Standards-based mathematics develops mathematical processes, mathematical practices, and mathematical strands of proficiency.

Teacher Development Activity (Example)

Use this five minute clip to decide what you could discuss with the teacher in a conference, based on what you notice the most. Be prepared to give a rationale.

- Mathematics content?
- Communication?
- General pedagogy?
- Something else?



Teacher Practice Activity (Example)

What traits would you desire to see in classroom mathematics teachers?

- Write one trait per Post-It note.
- Cluster traits into categories. Title each category.
- Share clustering/categories with another group.
  - What is similar?
  - What is different?

Communication Activity (Example)

- Take a moment to review the pre-conference viewing guide.
- As the video plays, take notes on your observation guide and transcripts.
- Use the transcripts to make notes of specific examples of coaching moves.

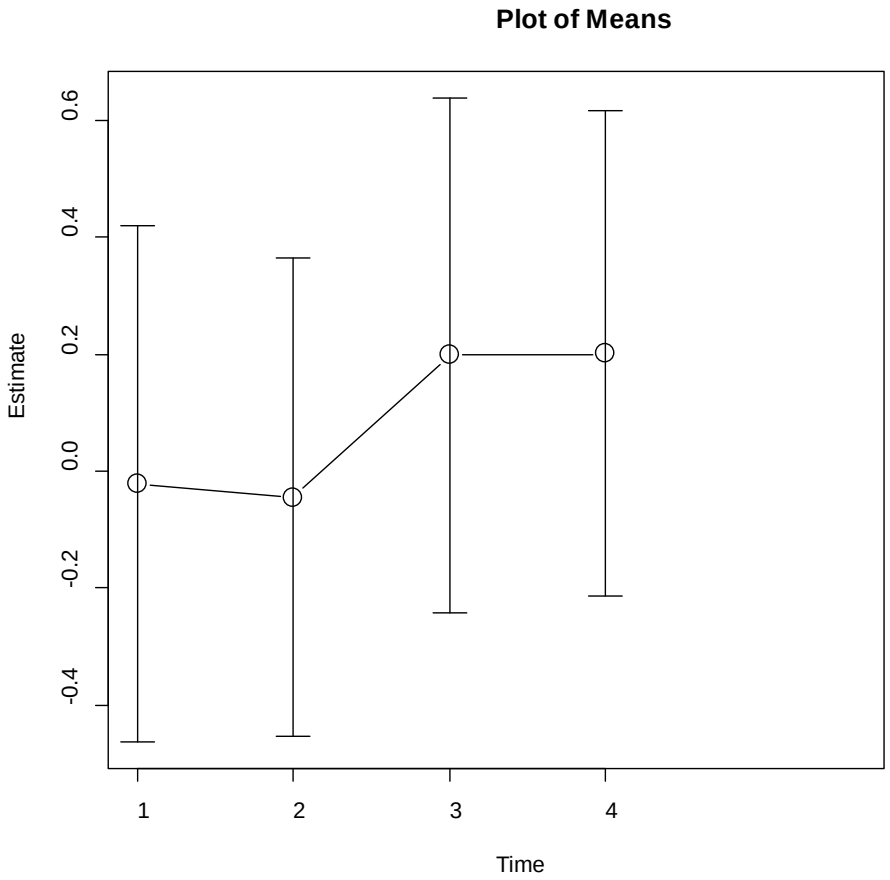
Leadership: Research Activity (Example)

- What is meant by "learning styles?"
- What does research say?
  - The term "learning styles" refers to the concept that individuals differ in regard to what mode of instruction or study is most effective for them.
  - …There is no adequate evidence base to justify incorporating learning styles assessments into general educational practice.
- Providing **all students** with the opportunity and expectation to understand mathematics using a **wide variety of instructional models and representations** is **standards-based**

Progress towards Research Goals

- Mathematics professional development has been offered once; Coaching PD has been offered twice
- Each has undergone minor revisions
- Have coaches in the treatment group gained knowledge?

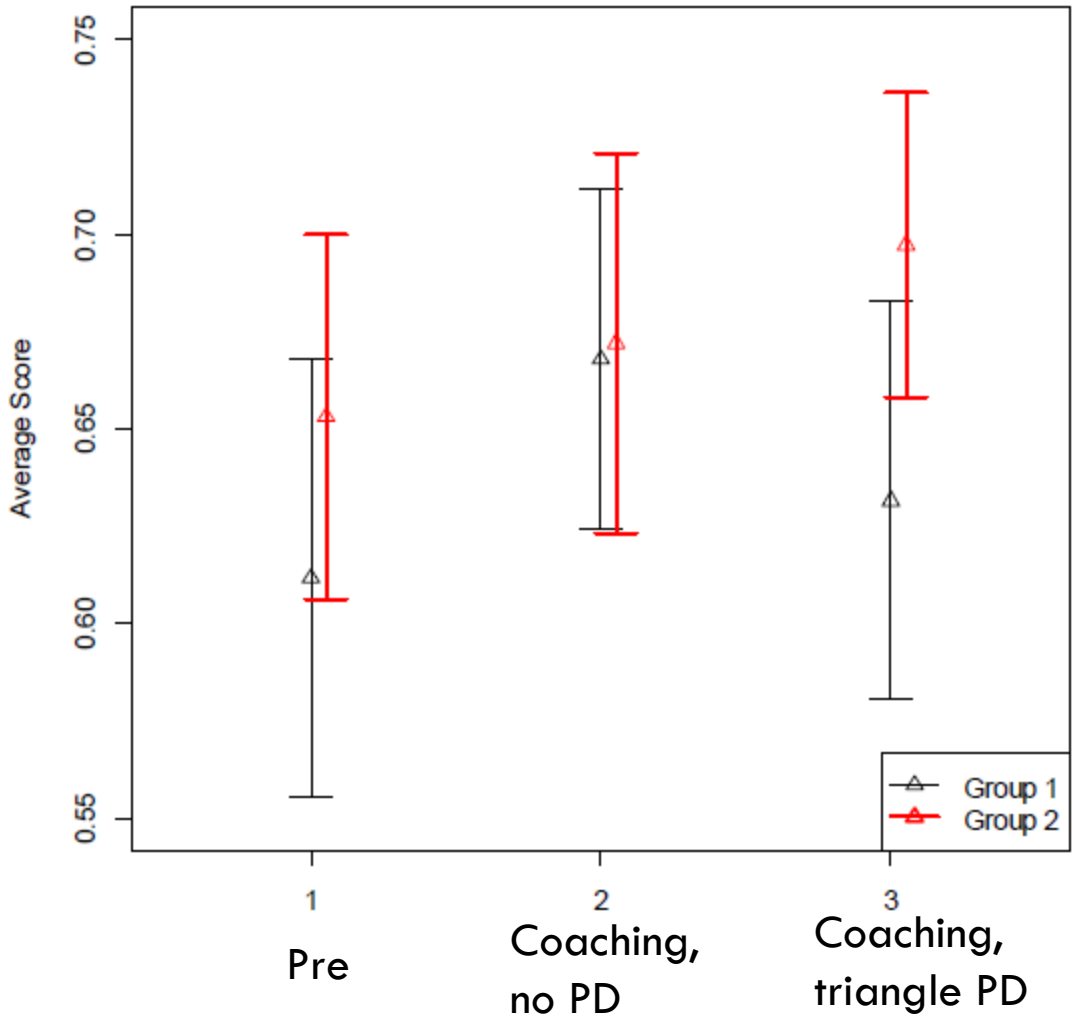
Early Results: Mathematics Content



Pre-pre-post-post

- No evidence of a treatment by time interaction (p-value=0.40)
- Estimated gains were higher in treatment than control group, but not large enough to detect a treatment effect (p-value=0.739)
- Evidence of a time effect (p-value=0.026)

Results: Coaching Knowledge



Estimated means of coach CKS conforming score, with 95% confidence intervals, as pre-test, before CKPD for either group, and after CKPD for group 2.

Ongoing Challenges

- Participant attrition – due to natural causes.
- Online component of PD
- No feedback after classroom observations of teachers

Broad Impacts

- We work in diverse instructional settings
  - Including districts that serve student populations that are primarily American Indian and Hispanic
  - Rural, urban and suburban school districts
- This project allows us to work meaningfully with school districts in Montana

Ongoing Research

- Longitudinal effects to be able to answer: is one type of knowledge more predictive of coaching effectiveness than the other?
- Are there specific knowledge areas or coaching practices that are correlated with coaching effectiveness?

Thank you!

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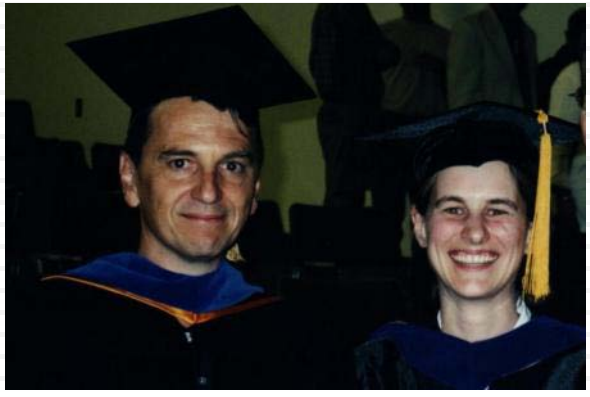


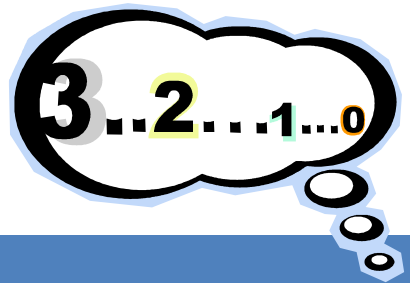
2003

2012

Mathematics Content Topics

Monday	Tuesday	Wednesday	Thursday	Friday
Number Sense	Computation	Fraction Concepts	Fraction Operations and Ratios	Proportional Reasoning and Percents

Number Sense



- It is important to select appropriate representations of numbers or numerical problems based on context.
- Factorization, divisibility and divisibility rules are based on mathematical structure.

Number Sense Activity (Example)

Here are several pairs of multiplication calculations.

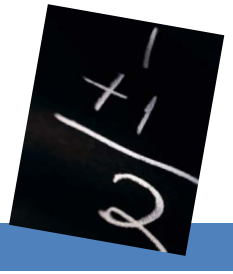
What pattern do you notice when you find the products?

24	27	35	45	48	36	156	144
×9	×8	×9	×7	×6	×8	×12	×13

Explain why, in each case, the products are the same.

Write another pair of multiplication problems with the same product.

Computation



- The properties of numbers and operations on numbers create structure that underlies computational methods, including algorithms.
- Multiplicative thinking is a skill to develop with all students.
- Models can be used to solve contextual problems, decide what operation is involved, and give meaning to number sentences.

Computation Activity (Example)

Write a story problem for 32 5 so that the question you pose would be answered by each of the following:

6 remainder 2

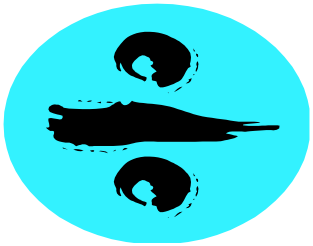
6 2/5

6.4

6 or 7

6

7



Fraction Concepts

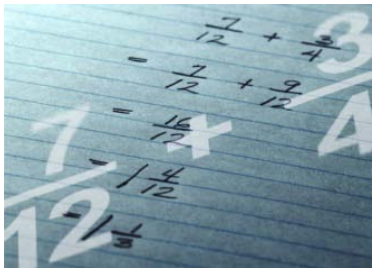
- Unitizing is the basis for fraction understanding.

- There are various models for representing fractions and these complement each other and enrich the meaning of fractions.

Fraction Operations and Ratios

- Models for fractions and their operations reveal structure that underlies computational methods.

- Various mathematical connections link ratios and fractions.



Proportional Reasoning and Percents

- Multiplicative reasoning is a fundamental component of proportional reasoning
- Proportional situations can be represented by a variety of models, and certain models promote sense-making in solving proportions

Coaching Cycle for EMC Project

There are three distinct parts to each coaching cycle designed to examine mathematics instruction.

- Pre-Lesson Conference (~15 minutes)
- Lesson Observation (entire class period)
- Post-Lesson Conference (~30 minutes)

Pre-lesson Conference

Purpose: to develop a shared view of the upcoming lesson

- Mathematical content and goal
- Instructional tools and strategies
- Potential challenges for students
- Areas of special focus for coach
- Evidence coach should collect

Lesson Observation

The coach's role is to be a data collector.

- Focus on the issue(s) discussed with the teacher in the pre-lesson conference.
- Document the relevant mathematics content and strategies used to teach it.
- Collect evidence of student learning.

Post-lesson conference

Purpose: Debrief and look ahead

- Analyze evidence together to interpret what students know and are able to do as a result of the lesson.
- Reflect on teacher moves that uncovered or advanced students' mathematical understanding.

Coaching Cycle for EMC Project

- The coaching cycle will be completed eight times per year with each of three teachers.

- Four of the eight coaching cycles will focus on Number Sense and Operations.

  This may look different at different grade levels, ranging from arithmetic to fractions and ratios to proportional reasoning.

Professional Development Design

- 45 hours, 1 week, residential
- Participants are all coaches enrolled in the research project
- Experience in mathematics coaching varies considerably
- Mathematical knowledge varies considerably

Coaching Knowledge PD