Analyzing Teachers’ Responses to Student Mathematical Contributions During Whole-Class Interactions: *Goals, Grain Sizes, and Coding Schemes*

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A Closer Look at Teacher Moves in Mathematically Responsive Interactions

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Beyond the “Move”: A Scheme for Coding Teachers’ Responses to Student Mathematical Thinking

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An Analysis of Two Different Approaches for Studying Teacher Responses

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Discussant

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Common Background

- Student mathematical thinking is
  - a feature of effective mathematics instruction that undergirds classroom mathematical discourse (e.g. NCTM, 2014)
  - difficult to incorporate into whole-class discussion (e.g., Leinhardt & Steele, 2005)
- Teachers' productive use of student thinking is
  - directly related to improvements in student achievement (Fennema et al. 1996)
  - supportive of student learning in general (e.g., Kazemi & Stipek, 2001)
- Attention to unit of analysis and methodological details

Core Principles Underlying Productive Use of Student Thinking

- [Student] mathematics is at the forefront
- Students are positioned as legitimate mathematical thinkers
- Students are engaged in sense making
- Students are working collaboratively

(Van Zoest, Peterson, Leatham & Stockero, 2016)

Focus of Our Work

Both projects study productive use of student thinking by examining ***teacher responses***

- *to episodes of student mathematical thinking relative to our core principles*
- *to instances of student mathematical thinking relative to our core principles*

A CASE STUDY OF TEACHER MOVES IN MATHEMATICALLY RESPONSIVE INTERACTIONS

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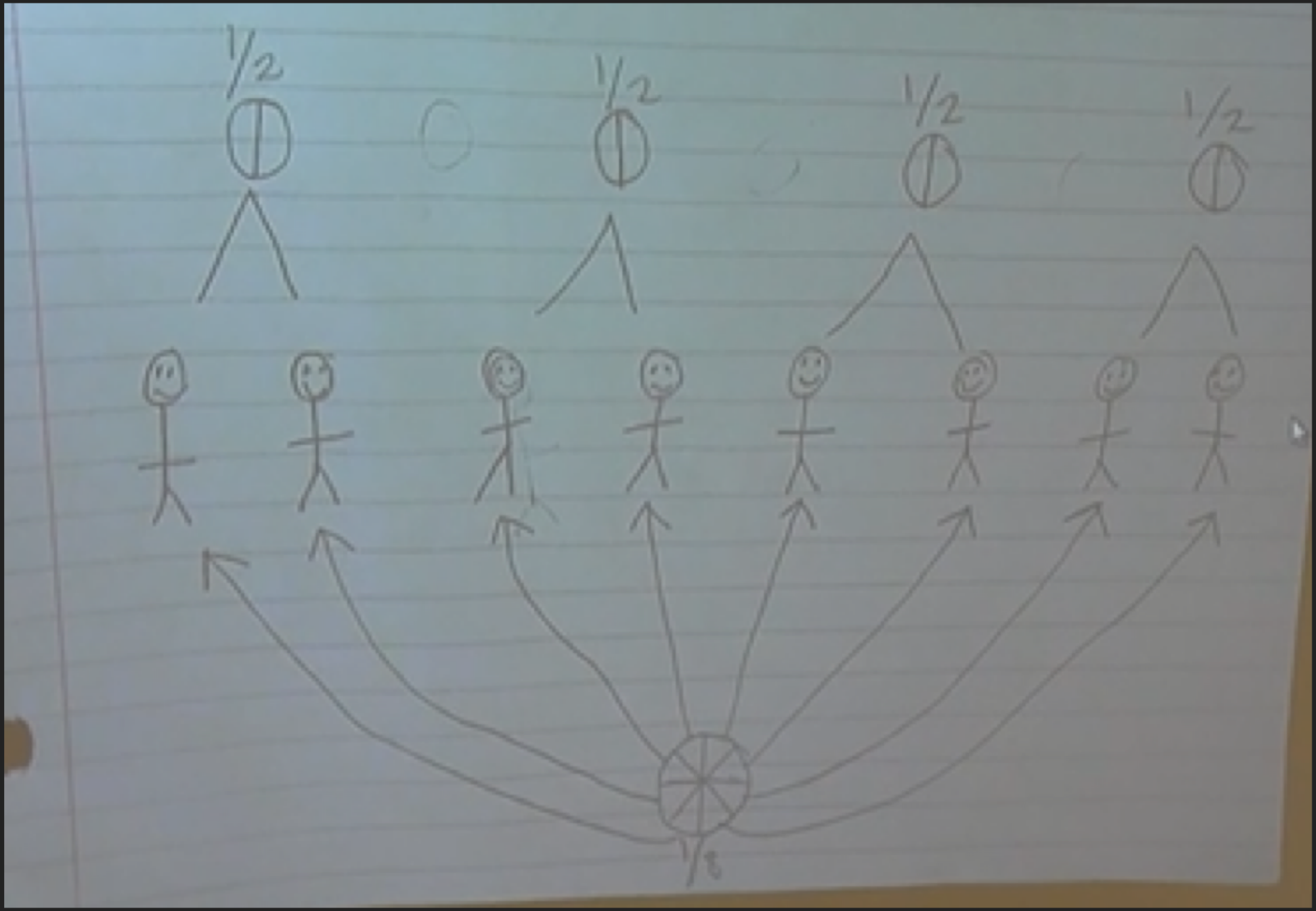
We describe classroom interactions that build on students' thinking and which students help to determine the direction of mathematics lessons as *responsive*. *Responsiveness* to students' mathematical thinking is a characteristic of interactions wherein student ideas are present, valued, attended to, and, at times, taken up as the basis of instruction.

SEGMENT 1: TCHR LE, GR 5, JAN 21
WRITING EQUATIONS FOR STRATEGIES



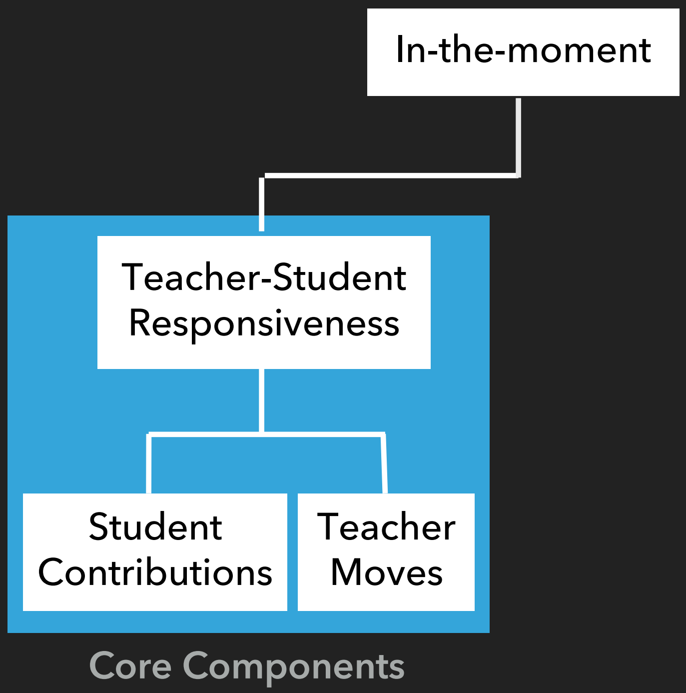
SEGMENT 1: TCHR LE, GR 5, JAN 21
WRITING EQUATIONS FOR STRATEGIES

- Teacher LE initially broadcasts Conerly's strategy and poses clarifying questions to Conerly. She then asks the class how to clarify Conerly's representation/drawing, who has a similar representation, and requests an equation that would represent Conerly's "problem."

SEGMENT 2: TCHR LE, GR 5, JAN 21
ADDING DENOMINATORS?

During class discussion about various equations that represent the burger problem (8 share 5) and different student solutions, Mary shares that 1/8 + 1/8 + 1/8 + 1/8 + 1/8 is the same as 2/16 + 2/16 + 1/8. This equivalence is based on her claim that 1/8 + 1/8 = 2/16. The class is investigating that claim.

OUR FRAMEWORK FOR MATHEMATICALLY RESPONSIVE INTERACTIONS (MRI)



FRAMEWORK GOALS & UNIT OF ANALYSIS

- Developed and refined for whole-class discussions over period of 2 years with data from 12 grades 5-7 classrooms and 1 first-grade classroom.
- Goals for framework included:
  - an ability to address substance of st ideas as well as whether/how teachers used those ideas;
  - capture variation in order to describe patterns in responsiveness and potential change;
  - accessible to teachers
- Unit of analysis is a segment defined as a series of turns of talk with a common focus (e.g., activity or strategy) and a consistent form of participation (whole-class, group work). A transition to a new segment may occur with the introduction of a new problem or task; a new strategy; or a shift in the main idea or focus of attention

CORE COMPONENTS OPERATIONALIZED

- Student Contributions: 4 ordered levels
  - None: no mathematical contributions made (teacher monologue)
  - Participating: Students calculate, recall, fill gaps in teacher's reasoning.
  - Explaining: Students explain mathematical ideas or strategies. **Segment 1**
  - Substantive Reasoning: In addition to explaining, students justify, conjecture, generalize, rebut. **Segment 2**

CORE COMPONENTS OPERATIONALIZED (CONT.)

- Teacher moves: 3 ordered levels
  - Confirming & Correcting: Student ideas are not used as foundation for instruction; moves include brush offs and evaluation.
  - Probing & Publicizing: Teacher moves focus on a particular student's thinking by probing and revoicing. **Segment 2**
  - Engaging Others: Teacher moves substantively engage students with mathematical ideas of others. **Segment 1**

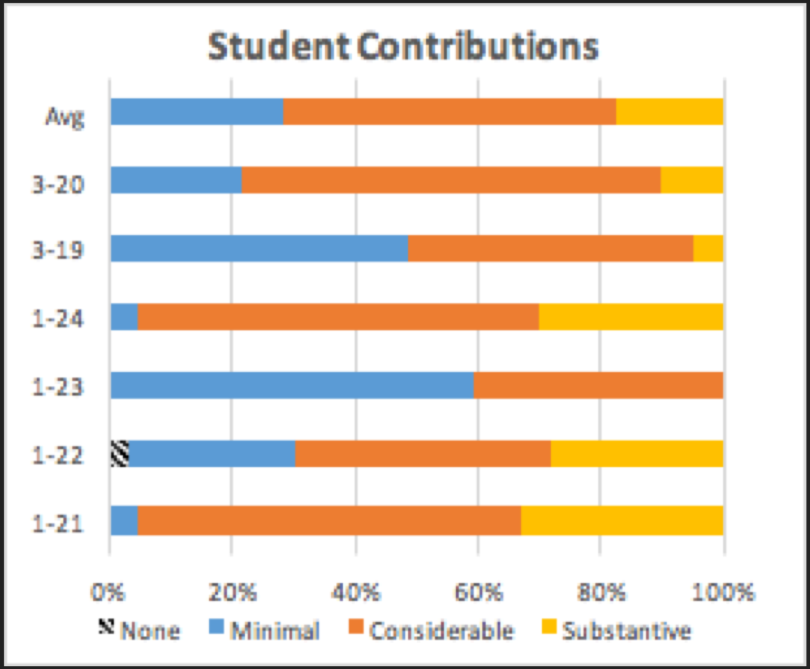
COMPOUND CODES: RELATING THE CORE COMPONENTS OF THE MRI FRAMEWORK

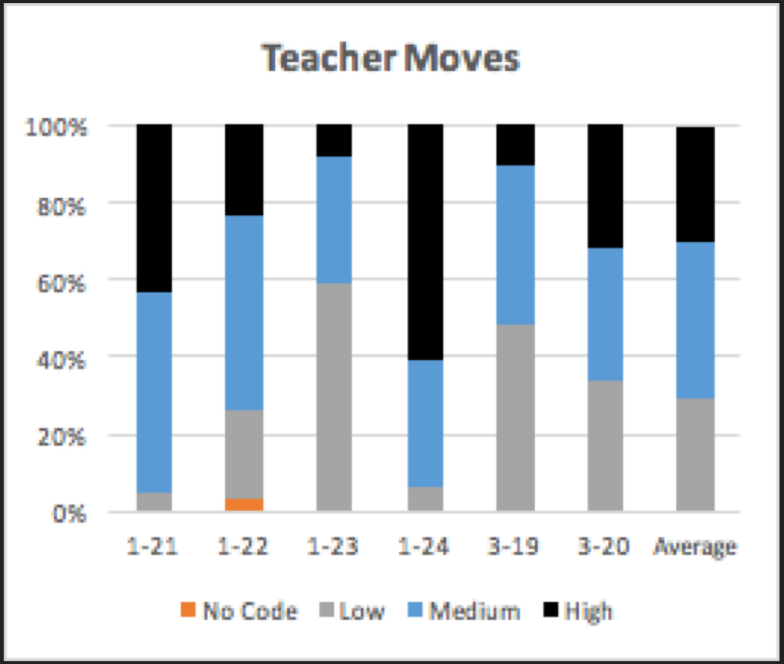
			Teacher Moves		
			Confirming & Correcting	Probing & Publicizing	Engaging Others
Student Contributions	None	Participating			
		Explaining			1
		Substantive Reasoning		2	

- Segment 1: Explaining, Engaging Others
- Segment 2: Substantive Reasoning , Probing & Publicizing

HOW TYPICAL ARE THESE KINDS OF INTERACTIONS?

CORE COMPONENTS FOR TCHR LE





- We found variability in responsiveness both *across* and *within* lessons. The 'bars' look different from day to day (and from teacher to teacher).

CORE COMPONENTS, COMPOUND CODES, TCHR LE

			Teacher Moves			
			Confirming & Correcting	Probing & Publicizing	Engaging Others	*Sums*
Student Contributions	None	Participating	26.2%	1.2%	0.4%	*27.7%*
	0.52%	Explaining	3.2%	31.0%	19.9%	*54.1%*
		Substantive Reasoning	0.0%	8.1%	9.6%	*17.7%*
		Sums	*29.4%*	*40.3%*	*29.8%*	

- We can begin to create profiles of mathematically responsive interactions for different classrooms, looking for trends and patterns.
- For example, in Tchr LE's classroom on average, 70% of the time in whole-class discussions are in the gray box; but Minimal-Low segments are significant and necessary.

STRENGTHS & LIMITATIONS

- Strengths
  - Identify patterns of responsive teaching moves and variability over time.
  - What are teachers' tendencies and what natural variation exists around those tendencies? (Stability)
  - What factors may be related to variation?
  - We characterize all portions of a whole-class discussion
- Limitations/Problems
  - How to handle segments with contradictory indicators? For example, a teacher is both responsive and not responsive to a student idea (brush off one idea to pursue another).
  - Descriptive power at the micro-level is sacrificed to consider how moves 'hang together' overall over a longer stretch of mathematical activity.

THANK YOU

QUESTIONS

LeveragingMOSTs.org

Beyond the "Move": A Scheme for Coding Teachers' Responses to Student Mathematical Thinking

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Literature on Teacher Responses

Mathematical Opportunities in Student Thinking

Three inter-related themes

- support for student participation in classroom communication (e.g., Chapin et al., 2009; Correnti et al., 2015)
- responsiveness to student thinking (e.g., Bishop, Hardison, & Przybyla-Kuchek, 2016; Dyer, 2016; van Zee & Minstrell, 1997)
- mathematical practices or ideas (e.g., Conner, et al., 2014; Franke et al., 2009; Selling, 2016)

Examples: Evaluating—Actions that center on the correctness of the mathematics
Requesting Evaluation—Asks students to evaluate a mathematical idea

Our Goal:
Capture distinctly multiple attributes of teacher responses (beyond the move)

Framework Development

Mathematical Opportunities in Student Thinking

- Initial development based on 6-12th grade data from the larger MOST project
- Analyzed teacher responses to:
  - 278 instances of high-potential student mathematics from whole-class interactions in 11 videotaped mathematics lessons
  - 198 instances of student mathematical thinking with varying potential from 25 Scenario Interviews

Key Constructs

Mathematical Opportunities in Student Thinking

- **instance of student thinking**: an observable student action or small collection of connected actions (such as a verbal expression combined with a gesture)
  - **student mathematics** (SM): the articulation of a reasoned inference about what the student is saying mathematically in the instance
  - **mathematical point** (MP): the articulation of the most closely related mathematical idea that can be gained from considering the instance of student thinking

(Leatham, Peterson, Stockero, & Van Zoest, 2015)

- **teacher response**: the collection of observable teacher actions that begins as a given instance of student mathematical thinking ends and concludes when the teacher turn ends or there is a clear shift to a different activity

Unit of Analysis

Teacher Response Coding Scheme (TRC)

MOST Mathematical Opportunities in Student Thinking

Actor			
Teacher	Same Student(s)	Other Student(s)	Whole Class

Recognition							
Actions			Ideas				
Explicit	Implicit	Not	Core	Peripheral	Other	Cannot Infer	Not Applicable

Mathematics					
Core	Peripheral	Other	Cannot Infer	Non-mathematical	Not Applicable

Moves						
Adjourn	Allow	Check-in	Clarify	Collect	Connect	Correct
Dismiss	Develop	Evaluate	Justify	Literal	Repeat	Validate
Dismiss	Develop	Evaluate	Justify	Literal	Repeat	Validate

Application of TRC – Context

While constructing a graph of a situation that related the amount of money accumulated by saving both a one-time gift and babysitting money that was earned weekly, a student said during class discussion, "I put the money on the bottom and weeks on the side.”

Application of TRC

Instance of Student Mathematical Thinking (SMT): "I put the money on the bottom and weeks on the side."

Student Mathematics (SM): I put the money on the x-axis and weeks on the y-axis.

Mathematical Point (MP): The placement of the variables on the axes of a graph is determined by what makes the most sense in the problem situation given the established convention of the x-axis representing the independent variable.

Possible Teacher Responses

Mathematical Opportunities in Student Thinking

SMT: "I put the money on the bottom and weeks on the side."

	Recognition				
Teacher Response	Actor	Actions	Ideas	Math	Move

MP: The placement of the variables on the axes of a graph is determined by what makes the most sense in the problem situation given the established convention of the x-axis representing the independent variable.

SM I put the money on the bottom … he side.

Recogni					
Teacher Response	Actor	Actions	Ideas	Math	Move
“Remember, we always put the independent variable on the x-axis.”	Teacher	Not	Peripheral	Peripheral	Correct

Possible Teacher Responses

Mathematical Opportunities in Student Thinking

SMT: "I put the money on the bottom and weeks on the side."

	Recognition				
Teacher Response	Actor	Actions	Ideas	Math	Move
"Remember, we always put the independent variable on the x-axis."	Teacher	Not	Peripheral	Peripheral	Correct
"Did anyone label the axes a different way?"	Whole Class	Implicit	Core	Cannot Infer	Collect

MP: The placement of the variables on the axes of a graph is determined by what makes the most sense in the problem situation given the established convention of the x-axis representing the independent variable.

SMT: I put the money on the bottom … he side.

Reco…					
Teacher Response	Actor	Actions		Math	Move
"Remember, we always put the independent variable on the x-axis."	Teacher	Not	Perip…	…ripheral	Correct
"Did anyone label the axes a different way?"	Whole Class	Implicit	Core	…annot Infer	Collect
[To same student] "Why is the amount of weeks dependent on the amount of money which you put on the bottom?"	Same Student	Explicit	Peripheral	Core	Justify

Possible Teacher Responses

SMT: "I put the money on the bottom and weeks on the side."

	Recognition				
Teacher Response	Actor	Actions	Ideas	Math	Move
"Remember, we always put the independent variable on the x-axis."	Teacher	Not	Peripheral	Peripheral	Correct
"Did anyone label the axes a different way?"	Whole Class	Implicit	Core	Cannot Infer	Collect
[To same student] "Why is the amount of weeks dependent on the amount of money which you put on the bottom?"	Same Student	Explicit	Peripheral	Core	Justify
[To another student] "And what do I like to do first when I make a graph?"	Other Student	Not	Other	Cannot Infer	Literal

TRC Strengths & Limitations

- Strengths
  - disentangles the teacher move from other characteristics of teachers' responses
    - the actor
    - the way in which the response honors student thinking
    - the mathematical focus
  - supports asking questions about these characteristics both individually and in connection with each other
- Limitations/Problems
  - labor intensive
  - need to do additional work to capture the big picture

Questions?

Contact Information

LeveragingMOSTs.org

An Analysis of Two Different Coding Schemes for Studying Teacher Responses

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AERA 2018 Annual Meeting, New York City

The Two Coding Schemes

Mathematically Responsive Interactions Coding Scheme (MRI)

- **Confirming & Correcting:** Student ideas are not used as foundation for instruction; moves include brush offs and evaluation.
- **Probing & Publicizing:** Teacher moves focus on a particular student's thinking by probing and revoicing.
- **Engaging Others:** Teacher moves substantively engage students with mathematical ideas of others.

Teacher Response Coding Scheme (TRC)

- **Actor:** Who has the opportunity to consider student thinking.
- **Recognition:** The extent to which the student who contributed the instance is likely to recognize their idea.
- **Mathematics:** The extent to which the response focuses on improving students' understanding of the mathematical point of the instance.
- **Move:** What the actor is doing or being asked to do with respect to the instance.

Data and Analysis

- Three excerpts of whole class mathematics discussions
  - Exemplary or problematic
  - Coded separately by both groups of researchers
- Analysis compared two groups' sets of codes and rationales
  - Examined what aspects of teacher responses were captured by the schemes
  - Examined the extent to which the unit of analysis impacted what was captured

Overview of MRI and TRC Differences

	MRI	TRC
Research Focus on Teacher Responses	Teacher Responsiveness	Various Foci based on Actor, Student Recognition, Mathematics, Move
Grain Size of Analysis	Collection of teacher responses to student thinking across a segment	Individual teacher responses to immediately preceding instance of student thinking
Coding Time per Lesson	Relatively brief in comparison to the TRC	Relatively extensive in comparison to the MRI

Excerpt 2: Elementary classroom discussion of a student strategy for an equal sharing task

Excerpt 2: MRI Coding

- *Engaging Others*
- Teacher interacting with and focusing the class on one student's strategy
- Student idea driving instruction, but in limited way

Excerpt 2: Sample of TRC Coding

Speaker	Instance	Actor	Recognition: Student Actions	Recognition: Student Ideas	Mathematics	Move
T:	Alright. A half and a half [teacher writes H's below F3 and F4]. So how many brownies does that take care of right there?	Teacher	Implicit	Peripheral	Core	Develop
CLASS	Two.					
T:	Two. Alright. So then he did it again [writes a second row of H's]. That takes care of?	Teacher	Explicit	Peripheral	Other	Develop
CLASS	Four.					
T:	Four of the brownies. [writes a third row of H's] That takes care of?	Teacher	Explicit	Peripheral	Other	Develop
CLASS	Six.					
T:	Six. [writes a fourth row of H's]	Teacher	Explicit	Peripheral	Other	Develop
CLASS	Eight.					
T:	[writes a fifth row of H's]	Teacher	Not	Peripheral	Other	Develop
CLASS	Ten.					
T:	Is that ten?	Whole Class	Explicit	Core	Core	Evaluate
CLASS	Yes.					

Excerpt 2: Comparison of Units of Analysis

- Unit of analysis impacted which student's mathematical thinking the teacher response incorporated
- MRI group's use of a segment
  - Focused on the way in which the teacher oriented the class to Dylan's thinking
- TRC group's use of individual teacher response
  - Compared the response to immediately preceding instance of student thinking, typically not Dylan

Different Affordances

- Attributes of the teacher responses captured
  - MRI focuses on responsiveness
  - TRC disentangles responsiveness and three other categories from the move
- The grain size of the unit of analysis
  - Collective nature (MRI) versus individual nature (TRC) of teacher responses
  - Search for patterns within discussions (TRC) versus patterns across lessons and classrooms (MRI)
- Student thinking that teacher response incorporates
  - Student thinking separated temporally (MRI)
  - Immediately preceding student thinking (TRC)
- The amount of time to code
- Potential benefit of using the two schemes together

Thank You!

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