Teaching for Robust Understanding

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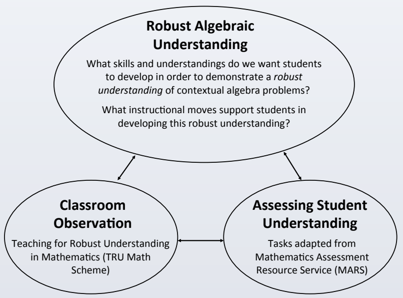
Project Overview

The Algebra Teaching Study (www.ATS.berkeley.edu) is working to develop a classroom observation scheme, TRU Math, in order to capture instructional practices and link them to students' robust understanding of algebra in contextual tasks.



This poster focuses on the TRU math scheme, which consists of 5 core dimensions, and a 6th, algebraic module, which focuses on robust understanding of contextual algebra problems.

Research Questions:

1. To what extent can we capture classroom practice across the dimensions of TRU Math?
2. Can we draw connections between these classroom profiles and student outcomes?

METHOD AND DESIGN

Classroom Data

- Recorded 7-8 lessons from ten 8th-grade algebra classes in Michigan and California using field notes and video.
- Coded representative lessons from two classrooms for instruction and student practice around 5 core dimensions of TRU Math Scheme (algebra module not included in these codings).

Student Data

- Students completed pre- and post-assessments consisting of tasks including both a multiple choice section (drawn from MCAS) and a free-response component (drawn from MARS).
- Rubrics were created and used to score student work that captured evidence of students' robust understanding (overall changes presented in this poster)

TRU Math Scheme Dimensions (General)

1. **Mathematical Coherence and Focus:** The extent to which the mathematics being discussed is correct, coherent, and focused.
2. **Cognitive Demand:** The extent to which classroom interactions create and maintain an environment of intellectual challenge.
3. **Access:** The extent to which classroom activity structures invite and support active engagement from all of the students in the classroom.
4. **Agency, Authority and Accountability:** The extent to which students conjecture, explain, and argue while adhering to mathematical norms.
5. **Uses of Assessment:** The extent to which student reasoning is elicited, challenged, and refined.

Sample Rubrics (Whole Class Discussion)

	How accurate, coherent, and well-justified is the mathematical content?	To what extent are students supported in grappling with and making sense of mathematical concepts?	To what extent does the teacher support access to meaningful participation for all students?	To what degree are students the source of ideas and discussion of them? How are student contributions framed?	To what extent does instruction build on student ideas or address misunderstandings when they arise?
1	Classroom activities are purely rote, OR disconnected or unfocused, OR consequential mistakes are left unaddressed.	Classroom activities call for students to apply familiar procedures or memorized facts.	Non-participation goes unaddressed, OR classroom management is problematic to the point where students' access to content is disrupted.	The teacher initiates conversations; students' speech turns are cursory and effectively constrained by what the teacher says or does.	The teacher may note student answers or work but reasoning is not surfaced or pursued. Teacher actions are limited to modeling correct procedures, corrective feedback or encouragement.
2	The mathematics discussed is is relatively clear and correct, BUT mathematical justification (ties to conceptual underpinnings) is lacking.	Classroom activities offer possibilities of conceptual richness or problem solving challenge, but students are mostly limited to providing short responses to teacher prompts.	The class is engaged in mathematical activity, but there is uneven participations and the teacher does not provide structured support for many students to participate meaningfully.	Students have a chance to say or explain things, but "the student proposes, the teacher disposes": in class discussions, student ideas are not explored or built upon.	The teacher refers to student thinking, perhaps even to common mistakes, but specific student ideas are not built on (when potentially valuable) or used to address challenges (when problematic).
3	The mathematics discussed is is relatively clear and correct, AND the mathematics is well justified (tied to conceptual underpinnings).	Classroom activities call for students to engage in complex, nonalgorithmic thinking, OR to connect concepts to other concepts OR to engage in an exploratory activity that frames concept or procedure. Challenges are not "scaffolded away."	Teacher moves support broad and meaningful participation, OR what appear to be established participation structures result in such participation.	Students put forth and defend their ideas, and teacher ascribes ownership for students' ideas in exposition, AND/OR students respond to and build on each others' ideas.	The teacher solicits student thinking and subsequent instruction responds to those ideas, by building on productive beginnings or addressing emerging misunderstandings.

Domain-Specific Module (Algebra)

	Reading and interpreting text, and understanding the contexts described in problem statements.	Identifying relevant quantities and articulating relationships between them	Generating representations of relationships between quantities	Interpreting and making connections between representations	Executing calculations and procedures with precision	Checking plausibility of results	Opportunities for Student Explanations	Teacher instruction about Explanations	Student Explanations and Justifications in Whole-Class Discussion
1	One or more terms in the problem are reworded and/or defined.	Salient quantities are identified but the relationships between quantities are not discussed.	Algebraic representation(s) is(are) generated by way of practice without attention to the relationship(s) between variables.	Representations are interpreted locally or in part. There are no connections between multiple representations.	Arithmetic calculations are executed accurately; any errors are corrected.	The plausibility of a solution is passively checked (e.g. teacher poses the question, "does this answer make sense?)	The task or teacher asks for student response to an open-ended question without explicitly eliciting an explanation or justification.	Teacher explicitly provides guidelines on what is needed *generally* for good explanations,	Student gives a short explanation that describes only procedures (whether algebraic or non-algebraic), OR the explanation is unclear.
2	The context (problem scenario) is elaborated or discussed and an explicit attempt is made to ensure students understand it.	Salient quantities are identified and local relationships between quantities are discussed (e.g. "what is the cost of plan A for 10 hours? Of Plan B?")	Algebraic representation(s) is(are) purposefully generated, but no attention to why the representation is a good choice for the given situation.	Important global features of representations are explicated to highlight covariation (e.g., the 'steepness' of a graph related to a rate of change).	Algebraic procedures (see list) are executed accurately; any errors are corrected.	The plausibility of a solution is actively checked without attending to context.	The task or teacher explicitly requests an explanation, but the nature of the explanation is not specific.	Teacher explicitly provides guidelines on what is *generally* needed for good explanations *and* models such behavior.	Student describes procedures, supporting them by referring to the problem context.
3	The teacher or students link the context (problem scenario) with algebraic concepts (e.g. rate of change, proportion, variable, expression).	General covariation of quantities is discussed either qualitatively, by generalizing patterns, or by identifying the relevant family of functions and the important attributes.	Algebraic representation(s) is(are) purposefully generated with explicit attention to the relationship between variables *and* attention to why the representation is a good choice for the given situation.	Important global features of representations are explicated to highlight covariation between quantities *and* connections among multiple representations are explored.	Calculations and/or algebraic procedures are executed correctly with explicit attention to accuracy; mistakes are caught and instruction involves guiding students to self assess errors.	The plausibility of a solution is actively checked in relationship to the context (problem scenario) to make sense of the solution.	The task or teacher explicitly requests an explanation that focuses on algebraic reasoning.	Teacher provides feedback on and/or opportunities for students to incorporate the feedback to revise *specific explanations*.	Student generates a clear algebraic explanation that extends beyond explaining how to do a procedure.

Coding Procedures

There are 2 key aspects:

- important types of classroom situations.
- important dimensions of the lesson, which we examine in those situations.

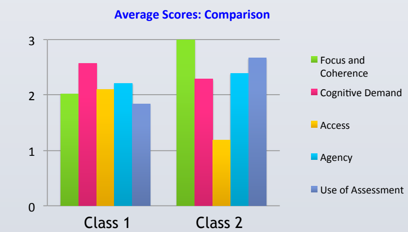
Coding takes place as follows:

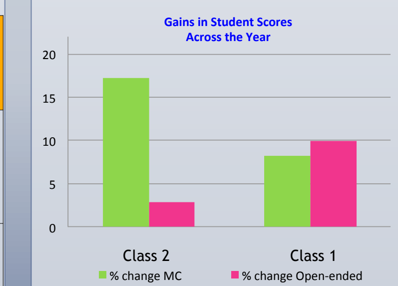
1. Each lesson is parsed into episodes (about 1-5 min.)
2. Each episode is identified as a specific type (see below)
3. Each episode is scored along the 6 dimensions.

Classroom Situations

- Whole Class discussions,
- Small Group work,
- Student Presentations,
- Individual work

Creating Classroom Profiles





Future Directions

- Expanded coding and analysis of classroom episodes
- Refining rubrics to capture classroom practice with greater nuance
- Expand scheme to other domains, such as geometry.

Acknowledgements

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