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.

Robust Algebraic Understanding
What skills and understandings do we want students to develop in order to demonstrate a robust understanding of contextual algebra problems?
What instructional moves support students in developing this robust understanding?

Classroom Observation
Teaching for Robust Understanding in Mathematics (TRU Math) Scheme

Assessing Student Understanding
Tools adapted from Mathematics Assessment Resource Service (MARS)

TRU Math Scheme Dimensions (General)

1. Mathematical Coherence and Focus: The extent to which the mathematics being discussed is 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, Equity, and Accountability: The extent to which students conjecture, explain, and on-the-fly adhere to mathematical norms.
5. Uses of Assessment: The extent to which student reasoning is elicited, challenged, and refined.

Sample Rubrics (Whole Class Discussion)

1. Classroom activities are purely rote, OR dishearteningly unenlightened, OR conceptual mistakes are left unaddressed.
   - Classroom activities call for students to apply familiar procedures and memorized facts.
   - Non-participation goes unsurpassed; 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 not study answers or work but reasoning is not surfaced or pursued. Teacher actions are limited to modeling correct procedures, correcting mistakes or encouraging.
   - The teacher refers to students thinking, thinking even to common mistakes, but specifically student ideas are not built on or explored (e.g. potentially valuable ideas are used to address challenges (when problematic)).

2. The mathematics discussed is relatively clear and correct, AND the mathematics is well justified (text to conceptual underpinnings).
   - Classroom activities offer possibilities of conceptual enrichment or problem solving challenges, but students are not making any short responses to teacher prompts.
   - The idea is engaged in mathematical activity, but there is uneven participation and the teacher does not consider support for many students to participate meaningfully.
   - Students have a chance to say or explain things, but the student proposes, the teacher accepts, and student ideas are not explored or built upon.
   - The teacher solicits students thinking and subsequent instruction responds to those ideas, by building on good contributions or addressing emerging misunderstandings.

3. The mathematics discussed is relatively clear and correct, AND the mathematics is well justified (text to conceptual underpinnings).
   - Classroom activities call for students to engage in complex, non-algorithmic thinking, OR to connect 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 to connect concepts OR to engage in an exploratory activity that frames concept or procedure. Challenges are not “scaffolded away.”
   - Students put forth and defend their ideas, and teacher ascribes ownership for students’ ideas in exposition AND students respond to and build on each other’s ideas.

TRU Math Scheme Dimensions (Algebra)

1. One or more terms in the problem are unknown/undefined.
   - Students articulated skillfully in identifying relevant quantities and relationships between them.
   - Students’ algebraic reasoning (sign, generating, by use of skill, without attention to the number of the given situation).
   - Students’ algebraic reasoning (by use of skill, number, without attention to the number of the given situation).
   - Students’ algebraic reasoning (by use of skill, number, with attention to the number of the given situation).

2. The context (problems concerned) is established or discussed and an explicit attempt is made to relate to students’ lives.
   - Students articulated skillfully in identifying relevant quantities and relationships between them.
   - Students’ algebraic reasoning (sign, generating, by use of skill, without attention to the number of the given situation).
   - Students’ algebraic reasoning (by use of skill, number, without attention to the number of the given situation).
   - Students’ algebraic reasoning (by use of skill, number, with attention to the number of the given situation).

3. The teacher’s feedback to students is consistent, aligned with algebraic examples.
   - Students articulated skillfully in identifying relevant quantities and relationships between them.
   - Students’ algebraic reasoning (sign, generating, by use of skill, without attention to the number of the given situation).
   - Students’ algebraic reasoning (by use of skill, number, without attention to the number of the given situation).
   - Students’ algebraic reasoning (by use of skill, number, with attention to the number of the given situation).

Domain-Specific Module (Algebra)

METHOD AND DESIGN

Classroom Data
- Recorded 7-8 lessons from ten 8th-grade algebra classes in Michigan 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 involving 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).

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.

Creating Classroom Profiles

Average Scores: Comparison

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

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