Student Participation in Meaning-Making and Reasoning

National Center for Teacher Effectiveness

Center for Education Policy Research
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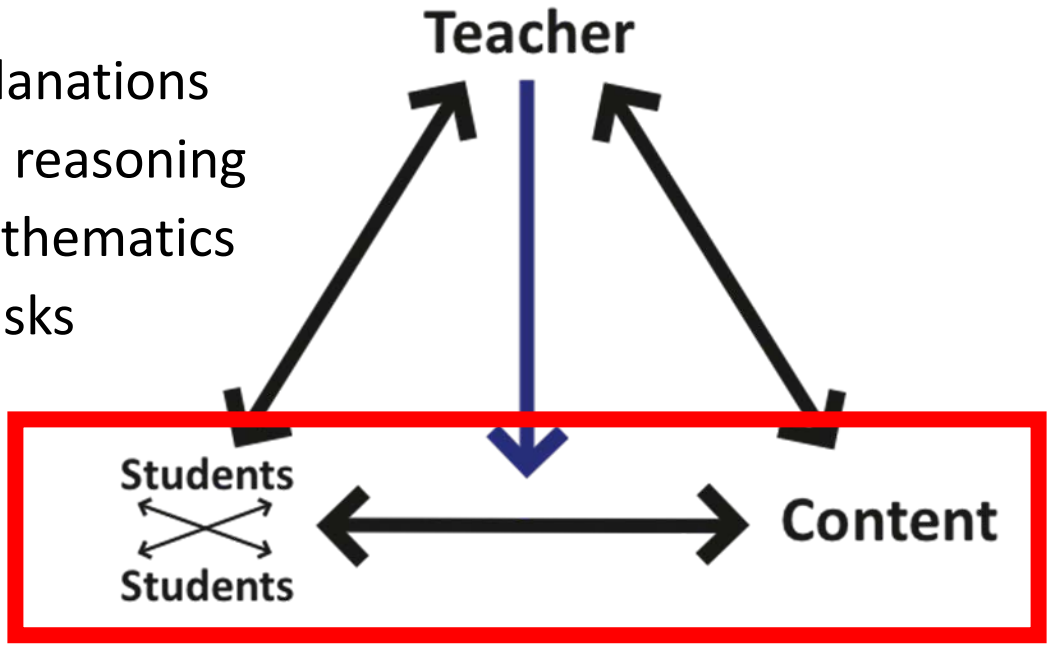
Student Participation in Meaning-Making and Reasoning

This dimension is intended to capture evidence of students' involvement in doing mathematics. Specifically, we look for:

- The extent to which students participate in and contribute to meaning-making through:
  - Their mathematical explanations
  - Engage in mathematical reasoning
  - Ask questions about mathematics
  - Engage in challenging tasks



Student Participation in Meaning-Making and Reasoning

- Codes for SPMMR:
  - Students provide explanations
  - Student mathematical questioning and reasoning
  - Enacted task cognitive activation
  - Overall SPMMR

Student Participation in Meaning-Making and Reasoning

Guiding Questions:

- Are students engaged in and participating with the mathematics? If so:
  - Are *students*, rather than the *teacher*, doing the mathematical work?
  - What is the level of engagement?

- Are students engaged in challenging mathematical tasks?
  - Are students engaged in the types of work mathematicians would engage in—conjecturing, justifying, pattern-recognition?

Students Provide Explanations

- *Definition*: A student provides an explanation that contains "why" and attends to the meaning of the mathematics.
- *Notes*:
  - The explanation can be initiated or co-constructed by/with the teacher.
  - The explanation does not have to be complete or correct.
  - If the student explanation meets the criteria under "richness" explanation, it can be counted in both places.

Students Provide Explanations

- *Examples*:
  - Students explain:
    - Why a statement or solution is true
    - Why a procedure works
    - What an answer means
    - Why a solution method is suitable or better than another

- *Distinguish from*: "How to," recitation of steps ("First I…then I…"), or a definition with no explanatory component.

Students Provide Explanations

- **Low (1)**: No student explanations
- **Mid (2)**: Explanations that are offered pertain to a specific problem/task, or are not generalized to key ideas or mathematical concepts
  - *Example*: a student explains that 3/4 is larger than 3/5 because the denominator in the first fraction is smaller than the denominator in the second fraction.
- **High (3)**: The explanation generalizes past specific tasks to address key mathematical concepts
  - *Example*: a student explains that 3/4 is larger than 3/5 because the denominator in the first fraction is smaller than the denominator in the second fraction *and that fractions with smaller denominators correspond to larger pieces*.

Student Mathematical Questioning and Reasoning

- *Definition*: Students ask a mathematical question and/or express a mathematical thought *other than* providing an explanation.
- *Note*: Students' contributions do not have to be complete or correct.
- *Examples*:
  - *Mathematically motivated questions*: "Why does this rule work?", "What about when *x* is zero?"
  - *Counter-claims and reasoning*: "I don't think Jai's method works because…"
  - *Conjectures*: "The parabola keeps getting skinnier every time we increase the coefficient."
- *Distinguish from*: explanations; questions that are not about mathematics (e.g., "Can we do this in our head?"); clarification questions (e.g., "Do you put the 4 here or here?"); simple negations without evidence given by the student (e.g., "No, he's wrong.")

Student Mathematical Questioning and Reasoning

- **Low (1):** No student questions or reasoning utterances
- **Mid (2)**: *One* or *two* student questions or reasoning utterances
- **High (3)**: *Three* or *more* student questions or reasoning utterances

Enacted Task Cognitive Activation

- *Definition*: The amount of mathematical invention, explanation, connection-forging, and so on, that students *do*.
- *Notes*:
  - Student confusion does not necessarily suggest that students are engaging with the content at a high cognitive level.
  - Working on review tasks/ideas does not necessarily mean that students are using lower order thinking skills.
- *Distinguish from*:
  - The difficulty of the task itself
    - *E.g.,* Do NOT use this code to note that integers are difficult for third graders
  - General student engagement and motivation
  - The task as stated (code enactment)
  - Poorly posed tasks and resultant student muddling should be coded as low (unsystematic exploration)

Enacted Task Cognitive Activation

- **Low (1)**:
  - Recalling/applying well established procedures, facts, rules, or formulas; OR
  - Applying procedures without attention to meaning; OR
  - Listening to a teacher with little student input; OR
  - Unsystematic exploration (i.e., task that is assigned results in some student mathematical work, but that work does not develop toward an overall mathematical point or goal)

Enacted Task Cognitive Activation

- **High (3):** Students make conjectures; look for patterns; make connections and attend to meaning of concepts, processes or relationships; explain and justify

- **Mid (2)**: Mix of high and low features. Includes cases where task starts high then teacher devolves; change in task level mid-segment; students working on same task at different level; direct instruction with some student involvement.

Overall SPMMR

- *Definition*: This code captures evidence of students' involvement in cognitively activating classroom work and the extent to which students participate in and contribute to meaning-making and reasoning. Do students contribute to the building of mathematical ideas or are they merely receiving knowledge?

Overall SPMMR

- **Low (1):**
  - Few or no examples of students engaging in SPMMR explanation, questioning, reasoning; OR
  - Tasks are largely procedural in nature; OR
  - Unproductive explorations in which students are off-track, mathematically
- **High (3):**
  - Students contribute substantially to building the mathematics and such contributions are a major feature of the segment; OR
  - Students engage in extended work on a challenging task
- **Mid (2):**
  - Students engage with content at *mixed level* (e.g., students may provide substantive explanations or ask mathematically motivated questions, but these are limited to isolated instances)
  - May also include tasks with variable enactment (high and low during segment)

Distinguishing SPMMR from Richness

- *Example*: Teacher asks students to solve 10 integer addition problems using colored chips
  - 5 problems involve adding with same sign, 5 problems involve adding with different signs
  - Students complete this work using number lines or manipulatives, then put answers on the board
- Scenario 1: Teacher A describes the pattern in the answer, then makes a mathematical generalization
- Scenario 2: Teacher B asks students to look for patterns; takes up student idea
- BOTH segments rated high for richness
  - But only second segment rated high for SPMMR

Notes on SPMMR

- Student meaning-making and reasoning can be observed in different situations such as:
  - During ***active instructional segments***, this mainly occurs through student mathematical statements: reasoning, explanations, question-asking.
  - During ***student work time***, this mainly occurs through work on a non-routine task.

Examples (Score for all 4 codes)

- Myles: Least Common Multiple
- Myles: Non-Linear Equations
- Noel: Right Angles
- Karen: Tourist Problem

Myles: Least Common Multiple

- 8th grade
- Connected Mathematics
- Beginning of the lesson; instruction focuses on the least common multiple and its application to solving algebraic equations

Myles: Least Common Multiple: Video

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How would you score this clip for:

- Students provide explanations
- Student questioning and reasoning
- Enacted task cognitive activation
- Overall SPMMR

- *Take a moment to write down your scores before moving on to our answers…*

Myles: Least Common Multiple: Answers

- Students provide explanations: **1**
  - none
- Student questioning and reasoning: **1**
  - none
- Enacted task cognitive activation: **1**
  - students listen to the teacher delivering instruction
- Overall SPMMR: **1**
- *Note*:
  - When he says “please don’t forget the other side of the equation” this could be counted as remediating-in-advance under the Working with Students dimension.

Myles: Non-Linear Equations

- 8th grade
- Connected Math Project curriculum (Growing, Growing, Growing)
- Class considers the point of intersection of two non-linear equations:
  - $y = 50(2.2)^x$
  - $y = 350(1.7)^x$

Myles: Non-Linear Equations: Video

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Myles: Non-Linear Equations: Answers

- Students provide explanations: **2**
  - Jade's explanation pertain to a specific problem
- Student questioning and reasoning: **3**
  - First counter-claim: "They would only intersect if they had the same growth factor"; second counter-claim: "If they had the same growth factor, then they'd be the same 'slope'"….additional throughout
- Enacted task cognitive activation: **3**
  - Pattern noticing; making and justifying predictions, offering explanations
- Overall: **3**

Noel: Right Angles

- 3rd grade
- In a previous lesson, the class discussed different cube attributes
- In this lesson, a student offers another attribute: “a cube has 24 angles”

Noel: Right Angles: Video

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How would you score this clip for:

- Students provide explanations
- Student questioning and reasoning
- Enacted task cognitive activation
- Overall SPMMR

- *Take a moment to write down your scores before moving on to our answers…*

Noel: Right Angles: Answers

- Students provide explanations: **3**
  - Global explanations, not for particular cubes
- Student questioning and reasoning: **3**
  - Several: initial conjecture; justification by another student; counter-claim and justification by another pair of students
- Enacted task cognitive activation: **3**
  - Looking for patterns, making and justifying conjectures, offering explanations
- Overall: **3**

Karen: Tourist Problem

- 5th grade
- Students have worked on this problem for about 30 minutes at their desks: “There were 54 tourists in a group. The women are twice as many as the men, and the children are three times as many as the men. How many women, men, and children were there?”
- Teacher scaffolds their work without providing answers; students come up with different solution approaches and the teacher asks one student to share her solution.

Karen: Tourist Problem: Video

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How would you score this clip for:

- Students provide explanations
- Student questioning and reasoning
- Enacted task cognitive activation
- Overall SPMMR

- *Take a moment to write down your scores before moving on to our answers…*

Karen: Tourist Problem: Answers

- Students provide explanations: **2**
  - Explanation pertains to the specific problem and is not global
- Student questioning and reasoning: **1**
  - none
- Enacted task cognitive activation: **2**
  - Mixed level – goes beyond low, but does not exemplify high (such as making conjectures, looking for patterns, and so on)
- Overall: **2**

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Please move on to the SPMMR practice module.

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