Analyzing student work as a reflection on practice

What ‘window’ into the classroom is provided by the student work samples from the 6th grade and 8th grade patterning tasks?
Analyzing student work as a reflection on practice: 

Tools for research and professional development

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Student work as a reflection on practice

• What does the set of work indicate about the quality of instruction and students’ learning opportunities?
  – classroom norms and practices?
  – instructional tasks and task implementation?
  – mathematical residue?
  – teacher standards for assessment?
19 toothpicks

Explanation: If the pattern were continued, 301 toothpicks would be needed for 100 squares. There are 6 squares for the example. On the top, there are 6 toothpicks and 6 toothpicks on the bottom. So if there were 100 boxes, there would be 100 toothpicks on both the top and bottom. So far that's 200 toothpicks all together. On the example, there are 7 toothpicks in the middle. The number of toothpicks in the middle by greater than the number of boxes. If greater than 100 boxes, 101 toothpicks. There are 101 toothpicks in the middle of the 100 boxes. 100 + 100 + 101 = 301 toothpicks. If the pattern were continued, 301 toothpicks would be needed for 100 squares. Say

If the pattern were continued, how many toothpicks would be needed for 100 square boxes? 301 toothpicks will be needed for 100 square boxes. Because each triangle really uses 3 toothpicks, until you get to the last one to close it up.

Example: \( \frac{2}{3} + \frac{2}{3} = \frac{4}{3} \) The last one needed to close it up.

\[ 3 \times 100 + 1 = 301 \]

\[ 3m + 1 = 301 \]
The number of the figure multiplied by itself is equal to the pattern.

\( \text{fig} \times \text{fig} + 4 \)

**a)** Any number (by itself) + 4

**b)** 5 + x

**c)** 25(25) = 625 + 4 = 629

**d)** 75(75) = 5625 + 4 = 5629

**e)** 100(100) = 10000 + 4 = 10004

**f)** 25

**g)** 75

**h)** 100

The answer is figure 7.
Measuring the quality of instruction using student work

*Instructional Quality Assessment*

*Mathematics Assignment Rubrics*
Instructional Quality Assessment Mathematics Assignment Rubrics

• Validity studies: Collections of student work provide stable indicators of classroom practice, highly correlated with observed instruction ($r = .68$, $p < .01$).

Matsumura, Garnier, Slater, & Boston, 2008
Clare and Aschbacher, 2001
Matsumura, Garnier, Pascal, & Valdes, 2002
Instructional Quality Assessment
Mathematics Assignment Rubrics

- Four sets of assignments
- Teacher provides:
  - At least four samples of students’ work per assignment (2 high, 2 medium)
  - Copies of tasks, rubrics, etc.
  - A cover sheet explaining expectations for high-quality work
- Rated by 2 raters
Instructional Quality Assessment
Mathematics Assignment Rubrics

Academic Rigor:
• Potential of the Task
• Implementation of the Task
• Rigor of students’ written responses
• Rigor of Teacher’s Expectations

Clear Expectations:
• Clarity and Detail of Expectations
• Students’ Access to Expectations
Instructional Quality Assessment
Mathematics Assignment Rubrics

Conceptual Basis:
• Levels of Cognitive Demand
  – Score levels for AR rubrics

• Mathematical Tasks Framework
  – Task Potential and Implementation

• Principles of Learning
  – Teacher’s Expectations

Resnick & Hall, 2001

Stein, Smith, Henningsen, & Silver, 2009
Instructional Quality Assessment
Mathematics Assignment Rubrics

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Mathematics Assignment Rubrics

Using the rubrics:

• Rate the *Potential of the Task* using rubric AR1
• Rate the *Implementation of the Task* using rubric AR2
AR1 and AR2 scores

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<th>Implementation</th>
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<td>2</td>
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<tr>
<td>Shading Squares</td>
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<td>3</td>
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<td>Equation Story Problems</td>
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Using student work as a research tool

Mathematical Practices Implementation Study
MPI Study

• Partnership between Education Development Center (EDC) and Michigan State University
• Seeks to characterize teacher practice and development during the first two years of implementation of CME Algebra I
Project Goals

- Understand teachers’ roles in implementing ambitious curricula
- Investigate relationships between teachers’ knowledge, instruction, & school contexts that influence a faithful implementation
- Identify conditions that contribute to effective advancement of high school mathematics reform
Key features of CME Algebra I

- Uses Mathematical Habits of Mind as an explicit design principle
- Majority of tasks are of high cognitive demand
- Supports discourse-based classrooms
- Designed to be educative for teachers
Design of the study

- Sample of 50 teachers at 12 sites
- First-year CME Algebra I implementation
- Moderate level of PD provided by EDC
- Data on teacher knowledge and practice
  - Mathematical Knowledge for Teaching
  - IQA Student Work Samples
  - Measures of curricular use
  - Habits of Mind assessment
The Role of Student Work

- Reliable measure of classroom practice for a significantly-sized sample
- Reduces burden and anxiety for teacher participants as compared to observations
- Affords comparisons across contexts
- Allows inferences to be drawn about students’ opportunities to learn beyond aggregate test scores
Preliminary Findings

- Relatively stable “learning curve” in implementing the curriculum
- Explicit conversations about habits of mind are followed by shifts in quality of instruction
- Mismatches between grading criteria and habits of mind can be fatal
Using student work as a research tool

Professional development research
Using the IQA Assignment rubrics in Professional development research

- Teachers from a variety of school districts
- Summer workshop
- Level of Cognitive Demand and Math Tasks Framework were central aspects of the PD
- Many teachers from large urban district not amenable to classroom observations

Research Question:
Following the workshop, could teachers implement a high-level task in ways that maintained the cognitive demands?
Using the IQA Assignment rubrics in Professional development research

Results:
(t = 10 teachers; 39 sets of student’s work)
- 33/39 (85%) high-level tasks
- 26/39 (67%) high-level implementations overall
- 26/33 (79%) HL tasks maintained
- 8/10 (80%) of teachers with at least 3 of 4 task implementations HL
- 8/10 (80%) teachers indicated that this type of instruction is not typical
Using the IQA Assignment rubrics in Professional development research

• Teachers with curriculum lacking HL tasks used open-ended assessment items or tasks from the workshop.
  – 13/39 (33%) of tasks were from the workshop.

• Tasks declined during implementation due to non-existent or low-quality explanations.
  – Improving students’ verbal and written explanations was frequently a problematic issue discussed by teachers in follow-up meetings.
Using student work as a reflection on practice
The sixth-grade lesson

- Students seated at tables. Asked to work on ‘Hexagon Pattern Train’ task
- Teacher circulates as students work; presses for explanations and reasoning
  - “What do you think S1? How does it relate to yesterday?”
- Whole group discussion illuminates 4 strategies
  - “So if x equals the numbers of trains…. Why do you think that works?”
The sixth-grade student work

The Toothpick Pattern:
- All 4 provided unique written explanations
- 3 different strategies present in the 4 samples of student work
- All student work samples used multiple representations
  - 3 of the 4 included an equation
  - 3 of the 4 used a diagram
The eighth-grade lesson

• Students seated in rows. No collaboration or talking permitted.
• Very specific directions given to students for solving a pattern task
• Teacher circulates; reminds students to follow directions; warns students to work faster to finish before the end of class.
• No whole-group discussion.
The eighth-grade student work

- Student work followed a ‘template’
- No unique explanations
- No references to the diagram of the pattern
- The pattern itself does not encourage multiple strategies
What does it indicate about instruction if...

• students solved the task in more than one way even though the directions did not specifically request multiple strategies?
• all or most of the students did not complete the cognitively challenging parts of the task?
• all students provide explanations similar in wording or all student work samples look ‘template’?
Closing

Questions and Comments
• How can the analysis of student work as a reflection on instruction be useful for teacher education?
• What are some advantages of using student work as a reflection on instruction?
• What are some caveats of using student work as a reflection on instruction?
• Questions from the audience?