Assessment to promote mathematics learning

Dr. Chris Suurtamm
University of Ottawa
September 2015
Overview of presentation

- Purposes of assessment
- Classroom assessment
- Large-scale assessment
- The interplay between classroom and large-scale assessment
- Supporting sound assessment
Assessment to Enhance Teaching and Learning
Suurtamm & Roth McDuffie, 2015

Editorial Panel
+ Ann Arden, OCDSB
+ Melissa Boston, Duquesne University
+ Sandra Crespo, Michigan State University
+ Nicole Rigelman, Portland State University
+ Ed Silver, University of Michigan
+ Denisse Thompson, University of South Florida
+ Dylan Wiliam, University of London

Organization
- Assessment in Action
- Design of assessment tools and strategies
- Professional learning to enhance assessment practice
- Assessment as evidence
Chapter on research in assessment for upcoming Research Companion to

Principles to Actions
Ensuring Mathematical Success for All

WHAT WORKS? Research into Practice
February 2015

Student Achievement Division

Making Space for Students to Think Mathematically

Dr. Christine Suurtamm, Brenna Quigley, and Jill Lazarus
University of Ottawa
## Beliefs about mathematics assessment

<table>
<thead>
<tr>
<th>Unproductive beliefs</th>
<th>Productive beliefs</th>
</tr>
</thead>
<tbody>
<tr>
<td>The primary purpose of assessment is accountability for students through report card marks or grades.</td>
<td>The primary purpose of assessment is to inform and improve the teaching and learning of mathematics.</td>
</tr>
<tr>
<td>Assessment in the classroom is an interruption of the instructional process.</td>
<td>Assessment is an ongoing process that is embedded in instruction to support student learning and make adjustments to instruction.</td>
</tr>
<tr>
<td>Only multiple-choice and other “objective” paper-and-pencil tests can measure mathematical knowledge reliably and accurately.</td>
<td>Mathematical understanding and processes can be measured through the use of a variety of assessment strategies and tasks.</td>
</tr>
<tr>
<td>A single assessment can be used to make important decisions about students and teachers.</td>
<td>Multiple data sources are needed to provide an accurate picture of teacher and student performance.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unproductive beliefs</th>
<th>Productive beliefs</th>
</tr>
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<tbody>
<tr>
<td>Assessment is something that is done to students.</td>
<td>Assessment is a process that should help students become better judges of their own work, assist them in recognizing high-quality work when they produce it, and support them in using evidence to advance their own learning.</td>
</tr>
<tr>
<td>Stopping teaching to review and take practice tests improves students’ performance on high-stakes tests.</td>
<td>Ongoing review and distributed practice within effective instruction are productive test preparation strategies.</td>
</tr>
</tbody>
</table>
Purposes of assessment
Assessment reform affirms that while assessment may be conducted for many reasons such as reporting on students’ achievement or monitoring the effectiveness of an instructional program, the central purpose of assessment should be to support and enhance student learning (Joint Committee on Standards for Educational Evaluation 2003; Wiliam 2007).

“The purpose of assessment is to improve student learning” (Ontario Ministry of Education, 1999, 2005)
Formative and Summative

Formative

If evidence is used to inform teaching and learning with a view to improve learning, then the assessment would be considered to have a formative purpose (Black & Wiliam, 2009).

Summative

If the evidence gathered from an assessment is used to provide a report on where the learning is at on a particular point in the learning process then the assessment would be considered to be serving a summative purpose (Black & Wiliam 2009; Wiliam 2015).
Research on formative assessment

- Formative assessment can make significant change in student achievement.

- Formative assessment helps all students but particularly low achievers. Thus it reduces the range of achievement while raising achievement overall (Black & Wiliam, 1998).
Features of formative assessment

- Pays attention to detail - what do students know, what can they do, what are next steps?

- How do students understand the concepts taught?
  - What are their understandings?
  - What are misconceptions?
  - What experiences do they have that connect?

Dr. Chris Suurtamm, University of Ottawa, 2015
### What do you use

<table>
<thead>
<tr>
<th>What do you use</th>
<th>To get a sense of student’s understanding (n = 1019)</th>
<th>To determine a report card mark (n = 1010)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper-and-pencil tests</td>
<td>somewhat and a lot 96%</td>
<td>somewhat and a lot 95%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>somewhat and a lot 89%</td>
<td>somewhat 79%</td>
</tr>
<tr>
<td>Performance tasks</td>
<td>somewhat and a lot 83%</td>
<td>somewhat 79%</td>
</tr>
<tr>
<td>Homework performance</td>
<td>somewhat 71%</td>
<td>somewhat 36%</td>
</tr>
<tr>
<td>Observations of students</td>
<td>somewhat 66%</td>
<td>somewhat 32%</td>
</tr>
<tr>
<td>Interviews/conferencing with students</td>
<td>somewhat 35%</td>
<td>somewhat 15%</td>
</tr>
<tr>
<td>Responses of students in class</td>
<td>somewhat 76%</td>
<td>somewhat 28%</td>
</tr>
<tr>
<td>Students' journals</td>
<td>somewhat 18%</td>
<td>somewhat 14%</td>
</tr>
<tr>
<td>Portfolios / dated work samples</td>
<td>somewhat 19%</td>
<td>somewhat 14%</td>
</tr>
<tr>
<td>Projects</td>
<td>somewhat 38%</td>
<td>somewhat 41%</td>
</tr>
</tbody>
</table>

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Suurtamm, Koch, Arden, 2010
Note that . . .

Assessments themselves are neither formative nor summative (Wiliam 2015). Rather, it is how the evidence generated by the assessment is used and the types of inferences that are made that make an assessment as formative or summative.
Classroom assessment
Sound classroom assessment...

- Is ongoing and imbedded in instruction
- Uses a variety of assessment strategies
- Is aligned with curriculum and instruction (e.g. use of technology, manipulatives, problem solving)
- Focuses on meaningful mathematics
- Is used to improve teaching and learning
- Includes students in the assessment process
Sound classroom assessment is on-going and embedded in instruction

Assessment is not an event but a process

- Paying attention to student thinking
- Recent research on “noticing” student thinking (e.g. Jacob, Lamb, and Philip, 2010)
- Questioning, listening, and responding
Integrating formative assessment and cognitively demanding tasks – reflections on the 5 practices (Silver & Smith, 2015)

- Anticipating
- Monitoring
- Selecting
- Sequencing
- Connecting

Smith, Stein, 2011
Sound classroom assessment uses a variety of assessment forms

Type into the chat pod the types of assessments you have observed being used in mathematics teaching and learning
Using a variety of assessment strategies

- Recognizes that students demonstrate their learning in different ways
- Provides multiple opportunities to show what they know and can do
- Takes into account the complex processes of doing mathematics
The importance of observation

In the primary grades:

“Young children show their understanding by doing, showing, and telling. Assessment strategies of watching, listening, and asking probing questions are needed to capture this.”

(Early Math Strategy Expert Panel Report)

Interviews with artifacts as a way of listening to young students’ understandings of number and operation (Young-Loveridge & Bicknell, 2015)
Sound classroom assessment is aligned with curriculum and instruction and focuses on meaningful mathematics

- Mathematical activity is complex and cannot be assessed with just one form of assessment
- Assessment should align with both the curriculum and instructional activities – includes the use of technology, manipulatives, collaborative work, etc.
- Assessment shows students what we value – if we merely assess skills – we are sending the message that this is all we value
Samples of mathematics curriculum verbs that demonstrate the complex actions in mathematics classrooms

**Mathematical Processes**

- Problem solving
- Reasoning and proving
- Reflecting
- Selecting Tools and Strategies
- Connecting
- Representing
- Communicating
How would you assess?

Students will:

- create and analyse designs involving translations, reflections, dilatations, and/or simple rotations of two-dimensional shapes, using a variety of tools (e.g., concrete materials, Mira, drawings, dynamic geometry software) and strategies (e.g., paper folding) (Sample problem: Identify transformations that may be observed in architecture or in artwork[e.g., in the art of M.C. Escher].);(Grade 7, Geometry and Spatial Sense)

Discuss and type in suggestions in the chat pod
Consider this expectation:

- estimate and calculate the area of composite two-dimensional shapes by decomposing into shapes with known area relationships (e.g., rectangle, parallelogram, triangle) (Sample problem: Decompose a pentagon into shapes with known area relationships to find the area of the pentagon.); (Grade 7 measurement)
Consider this task:

How might we change this task to incorporate some of the Mathematical Processes?

- Problem solving
- Reasoning and proving
- Reflecting
- Selecting Tools and Strategies
- Connecting
- Representing
- Communicating

Modification 1A: Sabrina wants to replace her kitchen counters (the shaded region) with mosaic tiles sold in 1-foot-square sheets. How many tile sheets will she need to complete the job? Use the diagram to show how you know your answer is correct. (Hunsader et al. 2014, p. 209)
Questions to ask regarding the mathematics assessed

- Can mathematical activity adequately be assessed using a ‘simple to score’ test?

- Are we choosing assessment tools because they are easy to mark or because they represent meaningful math?

- Does this assessment reflect what is important and what is relevant to this grade or course (respecting the continuum)?
Sound classroom assessment is used to improve teaching and learning

- Student responses inform teachers of next steps for instruction for class or individual students
- Feedback from peers and teachers inform students of their understandings and next steps
- Timely feedback appears to be key (Leahy & Wiliam, 2015)
Sound classroom assessment includes students in the assessment process

- Co-construction of rubrics and success criteria
- Sharing of samples of student work with students and discussing what they see
- Valuing what all students know and can do – thinking about self-referencing (rather than only criterion referencing)
- Developing self-assessment and metacognition
Co-construction of problem solving observation rubric for use with undergraduate students (Elrod & Strayer, 2015))

- **Reasoning & Proof**
- **Representations**
- **Communication**
- **Connections**
- **Productive Disposition**

<table>
<thead>
<tr>
<th>Reasoning &amp; Proof</th>
<th>Above Standard</th>
<th>Above Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student not only explains his/her own reasoning to others with clarity, completeness, and correctness, but also draws those sorts of explanations out of other students in the group.</td>
<td>Student demonstrates evidence of all four problem solving steps outlined in the “At Standard” description.</td>
<td></td>
</tr>
<tr>
<td>Representation</td>
<td>Student demonstrates multiple meaningful representations for the same problem.</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Student is actively engaged in drawing out others’ ideas and building upon them in small groups OR. Student is actively engaged in listening to and sharing ideas with others in whole-class discussions.</td>
<td></td>
</tr>
<tr>
<td>Connections</td>
<td>Student not only connects multiple mathematical ideas together, s/he recognizes and encourages others’ efforts to make those connections.</td>
<td>Student not only persists in his/her efforts to make those connections.</td>
</tr>
</tbody>
</table>
Sample of classroom assessment for a Grade 10 student

Dr. Chris Southam, University of Ottawa, 2015
What have you seen that could be described as **best practices** in classroom assessment in mathematics?

What do you see as some of the **challenges** regarding best assessment practices in mathematics?
Large-scale assessment
## Classroom Assessment vs Large-scale

<table>
<thead>
<tr>
<th>Classroom</th>
<th>Large-scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher developed &amp; scored</td>
<td>Externally developed &amp; scored</td>
</tr>
<tr>
<td>Frequent</td>
<td>Infrequent</td>
</tr>
<tr>
<td>Connected to learning activities</td>
<td>May not connect to learning activities</td>
</tr>
<tr>
<td>Includes a variety of assessment methods</td>
<td>Often pencil &amp; paper, multiple-choice and short answer items</td>
</tr>
<tr>
<td>Allows for detailed feedback to students</td>
<td>Feedback to students limited due to security</td>
</tr>
</tbody>
</table>
Appropriate interpretation of results

For individual students:

- results are one piece of information about a students’ performance based on one set of items administered at a specific point in time

- provide a general snapshot of some aspects of a students’ mathematics competence

- a students’ performance on the assessment may differ from their performance in the classroom
Appropriate Interpretation of Results

For schools & boards:

• EQAO results must be interpreted together with other important contextual data

• many factors affect school performance from year to year including changing teaching & admin staff, new school programs, shifting boundaries & student populations etc. etc.

• comparison from school to school or board to board is VERY limited and not the intention of EQAO

• Comparison from year to year within a school must be done considering contextual factors
Some reasons why students’ performance of the EQAO may be different than in class

- test anxiety, fatigue, or illness
- limited familiarity with m/c items
- unusual wording in the items or content that is not familiar to students
- assessment is a time-limited, pencil & paper format so certain aspects of mathematics such as investigation and extended problem solving are not measured ..... these may be areas where your program is strong and/or where an individual student excels !
Thermometer vs barometer

- Think of assessment data as a barometer rather than as a thermometer

- Assessment data demonstrates trends rather than the exact measurement of the current state
Interplay of large-scale and classroom assessment

Correlation between classroom assessment methods and achievement on large-scale assessment

Dr. Chris Suurtamm, University of Ottawa, 2015
Scores of students in classrooms where the teachers used a variety of assessment types (rarely used multiple choice)

Scores of students in classrooms where the teachers used mainly multiple multiple choice tests for assessment

Fig. 16.3. NAEP scale scores of eighth-grade students by categories of multiple-choice assessment use

(Walcott, Hudson, Mohr, & Essex, 2015, p. 184)
Supporting sound assessment practices
What have you done?

- Type into the chat pod ways that you have supported teachers in enhancing assessment in mathematics
Activities of professional learning communities

- Sharing assessment strategies and ideas
- Focusing on developing one or two new practices to enhance their assessment
- Bringing together student samples (hard copy, video) to discuss student thinking and next steps and/or to practice descriptive feedback
- Considering assessment strategies in terms of instructional and curricular alignment
- Considering how to involve students in the assessment process
Secondary teachers developed their expertise in:

- Formative quizzes
- Self-assessment
- Groups working on white boards
- Peer feedback

For teachers considering incorporating formative assessment elements into their practice, Wiliam (2011) cautioned against making several changes to teaching practice all at once. He notes that “when teachers try to change more than two or three things about their teaching at the same time, the typical result is that their teaching deteriorates and they go back to doing what they were doing before” (p. 161). Following Wiliam’s suggestion, in this setting we encouraged teachers to choose one technique to incorporate in their teaching, and if they found it successful, to continue with that one technique until it is a seamless part of their practice.

(Marynowski, 2015)
Assessment shows students what is valued

“Assessment determines to a great extent what learners perceive to be valid knowledge.” (Lund, 2008)


Thank you!