



An Overview of Mathematics Assessment with a Focus on Formative Assessment of ELLs/Latino Students

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Course Overview



- Day 1: A framework for mathematics tasks and its relationship to formative assessment.
Facilitator: Ed Silver
- Day 2: The Formative Assessment of ELLs of Rational Number Concepts
Facilitators: Rick Kitchen, Laura Burr, and Berenice Castellón
- Day 3: Introduction to a Formative Assessment Research Project of Rational Number Concepts with 6th Grade ELLs
Facilitators: Rick Kitchen, Laura Burr, and Berenice Castellón
- Day 4: Data Analysis from Formative Assessment Research Project with ELLs
Facilitators: Rick Kitchen, Laura Burr, and Berenice Castellón
- Day 5: More Data Analysis and Final Discussion of the Formative Assessment Research Project with ELLs
Facilitators: Rick Kitchen, Laura Burr, and Berenice Castellón

Day 2: The Formative Assessment of ELLs of Rational Number Concepts



Facilitators: Rick Kitchen, Laura Burr, and Berenice Castellón

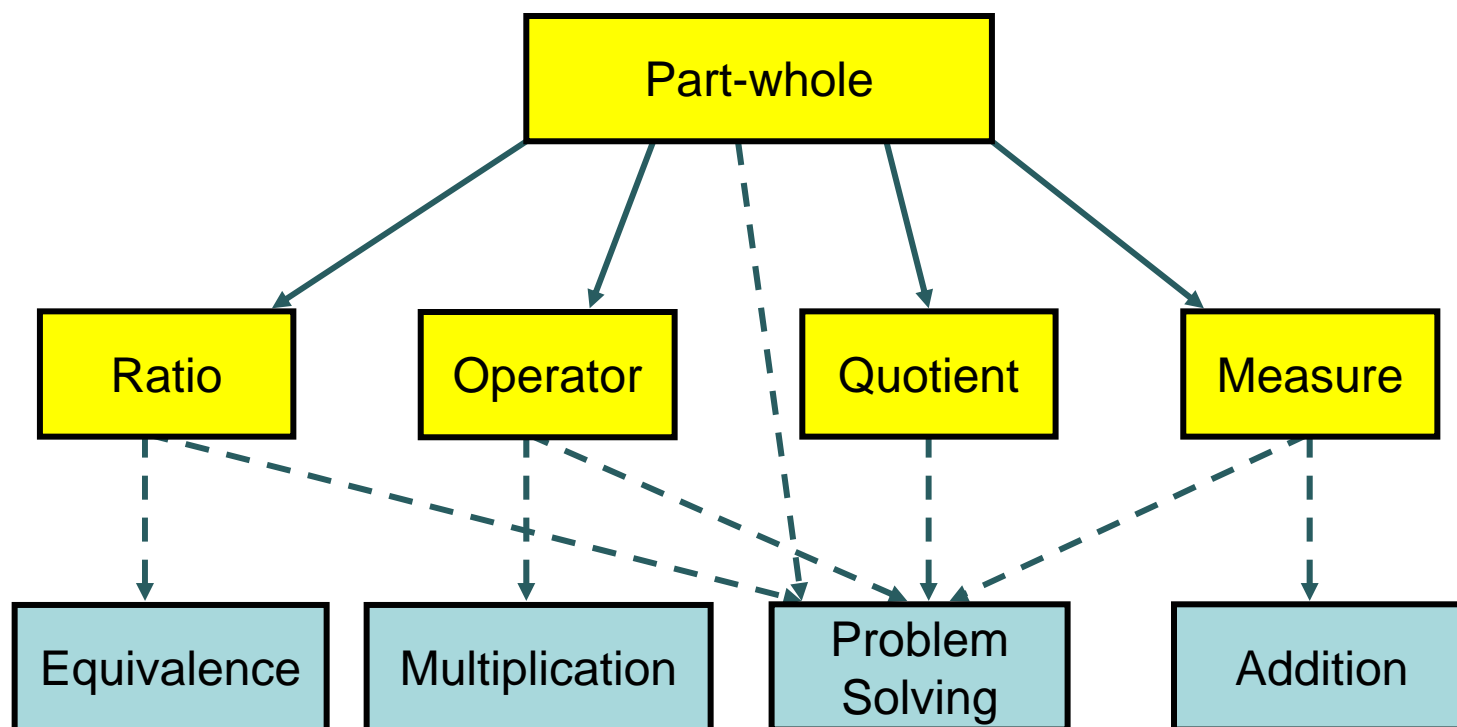
- Warm-up Activity: Work in groups to solve problems.
- Presentation and Discussion on the Five Fraction Subconstructs.
- Critical Question: What role could formative assessment play in the teaching and learning of fractions for understanding?
- Presentation and Discussion on Formative Assessment.

Fraction Subconstructs



- Epistemological and psychological stances.
- Psychological stance focuses on the schemas that children bring to the domain.
- Epistemological stance explains the nature of rational numbers as constructs and subconstructs (Moss & Case, 1999).
- The overview follows an epistemological stance because of the importance of students developing the ability to move among interpretations and how those interpretations influence methods to solve a mathematical task (Lamon, 2006).

The Five Fraction Subconstructs



Adapted from Charalambus & Pitta-Pantazi (2007)

Part-Whole Subconstruct



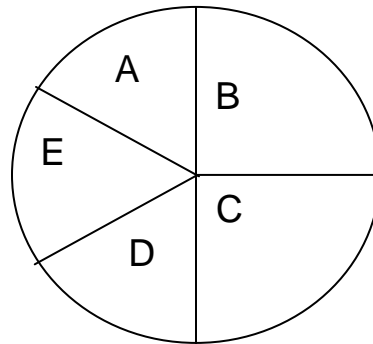
- Most common interpretation of fractions (Clarke, Roche, & Mitchel, 2007).
- Defined as the partition of a quantity or objects into parts of equal size.
- Strong understanding of the part-whole construct influences the understanding of equivalent fractions and the operations of addition and subtraction of fractions.
- Using part-whole language or thinking does not support understanding of fraction multiplication.

Example: *Part-Whole* Subconstruct



Fraction pie task

- What fraction of the circle is part B?
- What fraction of the circle is part D?



Adapted from Clarke, Roche, & Mitchel, 2007

- Note: To be successful in this task, the student should understand that the parts into which the whole is divided must be of equal size.

Ratio Subconstruct



- Defined as the comparison between two quantities or two sets (Clarke, Roche, & Mitchel, 2007; Charalambous, & Pitta-Pantazi, 2007).
- Not emphasized enough in the school curriculum (Clarke, Roche, & Mitchel, 2007).
- Lamon (2006) believes that there is no reason to delay the study of ratios until middle school, since children use ratios in sharing and comparing situations.

Example: *Ratio* Subconstruct



John and Mary are preparing orange juice for their party. Presented below are the recipes they used. What recipe will make the juice the most “orangey”?

John’s recipe:

three cups of concentrate juice-five cups of water.

Mary’s recipe:

four cups of concentrate juice-eight cups of water.



(Adapted from Charalambous and Pitta-Pantazi, 2007)

Operator Subconstruct



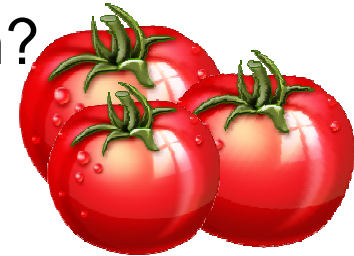
- An operator is a set of instructions (a function) for carrying out operations with fractions.
- One interpretation is stretcher/shrinker:

$$\frac{2}{3} \text{ of } 6 = \frac{2 \times 6}{3} \text{ or } \left(\frac{6}{3} \right) \times 2$$

Example: *Operator* Subconstruct



- Troy has $1 \frac{2}{5}$ as many baseball cards as I have. I have 55 cards. How many does Troy have?
- I canned 40 pounds of tomatoes last year. Maria canned $\frac{3}{8}$ as many. How many pounds did Jan can?



(Adapted from Lamon, 2006)

Quotient Subconstruct

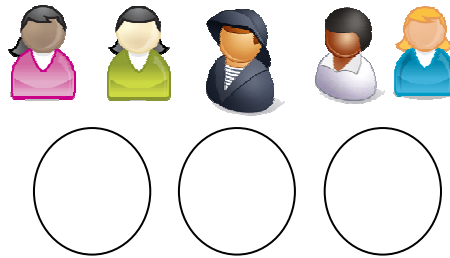


- Also called division, can be seen as the numerical value of a/b .
- This subconstruct can be exemplified through partitioning and equal sharing (Lamon, 2007; Clarke, Roche, & Mitchell, 2007; Charalambous & Pitta-Pantazi, 2007).
- Since the result of a/b refers to the numerical value and not to the parts, there is no restriction with regards to the fraction size.

Example: *Quotient* Subconstruct



- Three pizzas were shared equally between five girls.
How much does each girl get?



(Adapted from Clarke, Roche, and Mitchell, 2007)

- Note: Clarke, et al. found that 11.8% of students were unable to correctly solve the task. They suggest more exposure to this kind of problem and propose connecting division with fractions to help students to make the generalization that $a \div b = a/b$.

Measure Subconstruct



- It has to do with the notions of the unit and subintervals, equivalence, and the idea of density of the rational numbers (Lamon, 2007).
- Associated with using number lines and showing that the number of equal parts in a unit can vary depending on the number of partitions (Clarke, Roche, & Mitchell, 2007; Charalambous & Pitta-Pantazi, 2007).
- Students can develop strong notions of the operations of addition and subtraction by mastering the measure subconstruct (Lamon, 2007).

Example: *Measure* Subconstruct



1. Locate number one on each of the following number lines.



2. Name one fraction that appears between $\frac{1}{8}$ and $\frac{1}{9}$.
(Adapted from Charalambous and Pitta-Pantazi, 2007).



What strategies hold great promise to document and assess the learning of Hispanic students of fractions?

Introduction to Formative Assessment



- Formative Assessment: Assessment that focuses on teachers' responses to the student learning data they encounter on a daily basis. (Wilson & Kenney, 2003)
- After examining 250 research studies on classroom assessment, Black and William (1998) found that when teachers focus on formative assessment, student achievement gains are “among the largest ever reported for educational interventions.”

Some Background on Various Theories and Their Significance for Formative Assessment



- Dominant 20th-century paradigm included social efficiency theory (e.g., managing schools like factories), behaviorism (learning as the accumulation of bits of knowledge), and scientific measurement (e.g., objective tests to measure achievement).
- In this paradigm, assessment is viewed as an official event, separate from instruction.
- Assessments should be “objective” and should be uniformly administered.

Social-Constructivist Conceptual Framework



- The emergent social-constructivist paradigm borrows from cognitive, constructivist, and sociocultural theories. (Shepard, 2000)
- In this paradigm, learning is now understood as an active process of mental construction and sense making. (Vygotsky, 1979)
- Learning is developed through socially supported interactions.
- A commitment is made to equitable and just educational opportunities for all learners.
- Classroom expectations and social norms should foster the development of important dispositions, such as students' willingness to persist in trying to solve difficult problems.

How Assessment Should Change in this new Paradigm



- Form and content must be changed to better represent important thinking and problem solving skills, and
- The way assessment is used in classrooms and how it is regarded by teachers and students must change.

Assessment Formats that Align with the Creation of a Learning Culture



- Dynamic assessment,
- Assessment of prior knowledge,
- The use of feedback,
- Teaching for transfer,
- Explicit criteria,
- Student self-assessment, and
- Evaluation of teaching.

Role of Research for Improving Classroom Assessment



- Shepard and others (e.g., Schoenfeld, 1999) highlight need for research that advances fundamental understandings while working to solve practical problems in real-world settings.
- In our research, we set out to do exactly this!

Day 3: Introduction to a Formative Assessment
Research Project of Rational Number
Concepts with 6th Grade ELLs

Facilitators: Rick Kitchen, Laura Burr, and Berenice Castellón



Using a Socio-Constructivist
framework, we sought to study
how formative assessment could
contribute to student
understanding of fractions.

Research Design



- This spring, we designed a research protocol that included a progression of clinical interviews that were conducted with four students.
- The protocol has four stages:
 - (1) Students were asked to estimate solutions to a series of mathematical tasks;
 - (2) Students completed the tasks in writing while working alone;
 - (3) Follow-up interviews were conducted with each of the four students in which students initially explained their task solutions; and then
 - (4) Students were asked in a telephone-simulation interview to explain their solutions to someone who did not have access to the tasks.
- For all four stages, students could speak/write in Spanish or English. We videotaped students during stages 1, 3, and 4.
- All the tasks were based on problems from the Bits & Pieces I, II and III units in the CMP and were specifically selected because of their focus on student understanding of fractions, decimals, and proportional reasoning.

Purposes of Assessments



Our purposes for pre- and post-assessments:

- Reveal what students know and “gaps” in their knowledge;
- Provide students with a learning experience as they solve the tasks;
- Reveal their deeper understanding through questioning (i.e., mathematical knowledge and connections they could make).

Our Research Questions



- (1). What strategies hold great promise to document and assess the learning of Hispanic/Latino students of fractions?
- (2). How can formative assessments of sixth-grade ELLs be used as a means to develop and understand ELL's "voice" in mathematics?
- (3). What do sixth-grade ELL students understand well and what are their mathematical "gaps" particularly with regards to fractions?
- (4). What can we learn from mathematical assessments of ELL students' understanding of fractions to inform classroom instruction?
- (5). What classroom-level assessment formats (both formal and informal) foster or inhibit the demonstration of mathematical knowledge and proficiency by sixth-grade Hispanic students?
- (6). What role does language play for sixth-grade ELLs learning fractions?

Goals for Today and Tomorrow



- View transcripts that have been organized for analysis by research question posed.
- Share both individual and group interpretations of transcripts analyzed.
- Generate new research questions???

Video/Transcript Observation Protocol



- (0). Choose readers and read the transcript aloud.
- (1). Analyze transcript with intent of answering research question posed.
- (2). Discuss observations and analyses in your group of the transcript read vis-à-vis research question posed.
- (3). Write down and be prepared to share group analyses of transcript vis-à-vis research question posed on chart paper provided.
- (4). Groups share out their collective analyses of transcript.

Day 5: Final Discussion of the Formative Assessment
Research Project with ELLs

Facilitators: Rick Kitchen, Laura Burr, and Berenice Castellón



Today's Agenda:

- View a few more transcripts. (25 mins)
- Engage in group discussions of critical questions (15 mins)
- Share out on discussions. (30 mins)
- Final ruminations (20 mins)

Critical Questions



- What are the political challenges associated with preparing teachers to assess in the socio-constructivist paradigm at a time of intense teacher “deskilling” through curricular scripting and test prep?
- What research questions do you have about the formative assessment of ELLs in the mathematics classroom?
- What should be done in teacher education to help prepare prospective teachers to be able to align formative assessment practices with the new socio-constructivist paradigm?

Final Ruminations



- Goal of dynamic learning environments is to motivate student learning while developing identities as capable learners.
- Need for cognitively demanding, “quality” tasks that engage students in mathematics.
- To transform classrooms into dynamic learning environments, the purpose of assessment must be to help students learn and to improve instruction rather than to just rank students and certify end products of learning.
- Questions about the role of research to transform the educational landscape.



THANKS