The Role of Learning Progressions to Support the Development and Use of Mathematics Formative Assessment Tasks

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Formative Assessment

Formative assessment is a process used by teachers and students during instruction that provides feedback to adjust ongoing teaching and learning to improve students' achievement of intended instructional outcomes.

Council of Chief State School Officers(2008).

Learning Progressions

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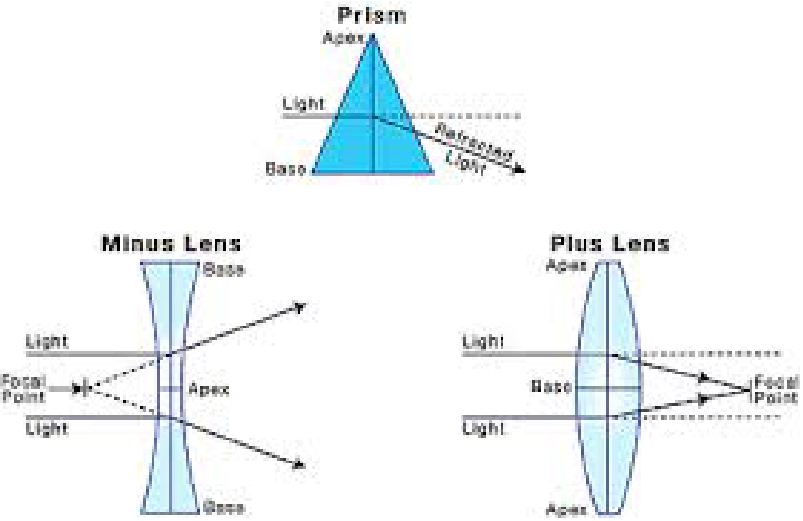
- Finally, a progression is provisional, subject to empirical verification and theoretical challenge

Why Use Them?



Learning progressions (Heritage, 2008) can serve as a “cognitive lens” through which teachers can view student evidence to make hypotheses about students’ progress with respect to specific milestones, as well as their profile of partial understandings.

Interpretive Lens for Standards

6th grade

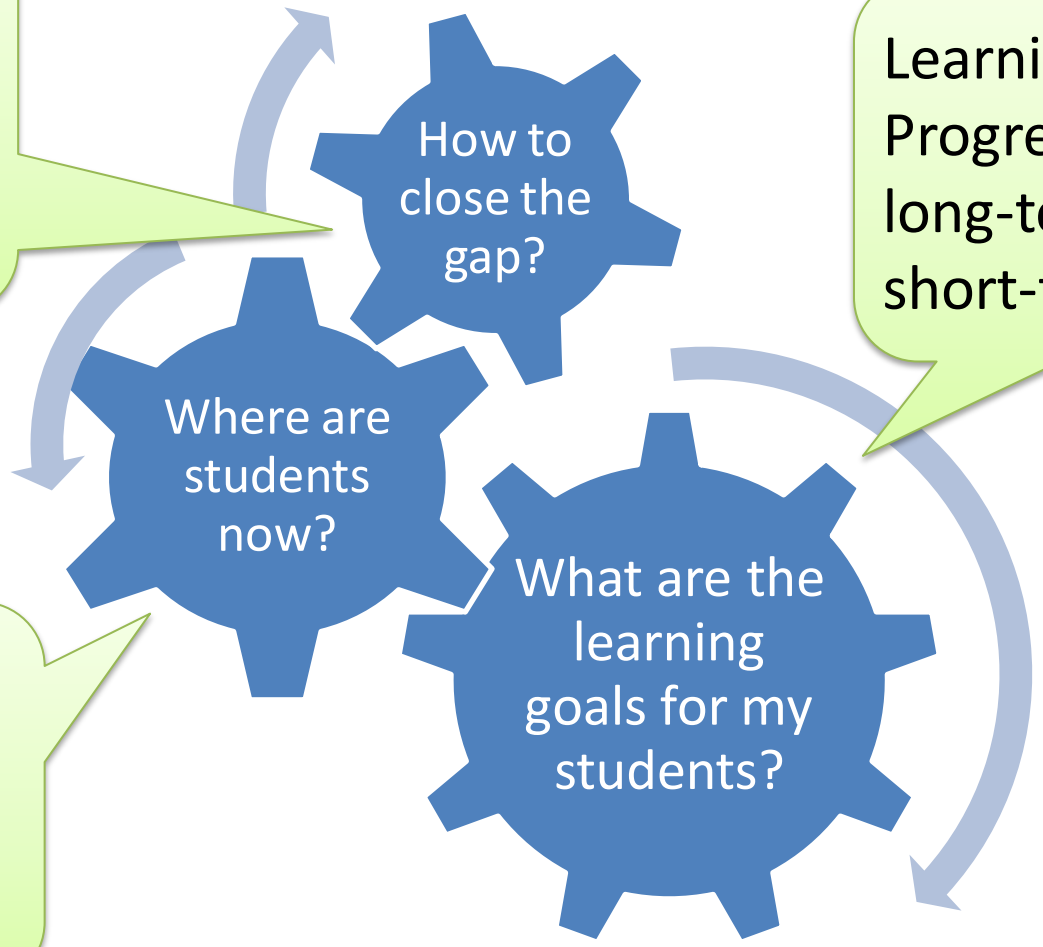
- Understand ratio concepts and use ratio reasoning to solve problems.

7th grade

- Analyze proportional relationships and use them to solve real-world and mathematical problems

Connecting Formative Assessment and Learning Progressions

Target the transition between levels



Learning Progressions: long-term and short-term goals

Assessment tasks structured to target LP

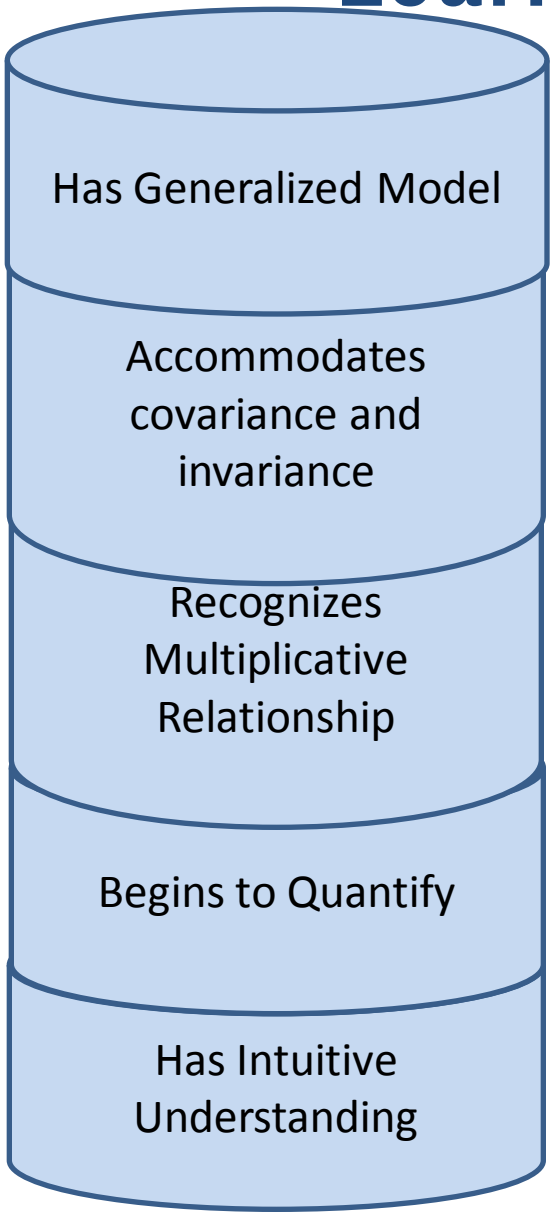
Our Current IES Project

- Three learning progressions
  - Equality and Variable
  - Function and Linear Functions
  - Proportional Reasoning
- Two assessment formats
  - A "locator" test
  - Incremental tasks
- Three phases
  - ✓ Phase 1: Development and early teacher feedback
  - ✓ Phase 2: Validity studies
  - ➔ Phase 3: Consequential validity study

Proportional Reasoning Learning Progression

Level	Description of Levels	Student Strategies Associated with Levels
1	Intuitive understanding, qualitative relationships	Absolute Reasoning Qualitative Reasoning
2	Beginning quantification	Additive Misconception Reverses Ratios
3	Multiplicative relationship	Build-up Strategy Cross-multiplication
4	Understands covariance and invariance	Scalar Strategy
5	Generalized model of proportionality, can work with more than two ratios	Successfully works with more than two ratios

Proportional Reasoning Provisional Learning Progression



Student has a generalized model for solving proportionality problems. Student has a repertoire of strategies and uses the most efficient for a given situation. (Goes far beyond setting up proportion and cross multiplying.)

Student knows that if one number in a ratio changes that the other number must change by the same factor (that's the covariance) and they know that equivalent ratios all reduce to the same ratio (that's the invariance).Student uses multiplication to generate equivalent ratios—e.g.,

$$\frac{1}{2}=\frac{2}{4}=\frac{3}{6}=\frac{n}{2n}$$

Student some understanding of the multiplicative relationship between equivalent ratios but may use additive strategies to generate equivalent ratios—e.g,

$$\frac{1}{2}=\frac{1+1}{2+2}=\frac{2}{4}=\frac{2+1}{4+2}=\frac{3}{6}$$

Student's notion of ratio starts to develop, he can work with one ratio but may have trouble comparing to another ratio. May have additive misconception—e.g.,

$$\frac{1}{2}=\frac{1+1}{2+1}=\frac{2}{3}$$

Student has an intuitive understanding that allows qualitative comparisons of more or less—e.g., which drink is sweeter.

Source: Baxter and Junker, 2001 (cited in Weaver and Junker, 2004)

Locator Items

- Short computer-delivered assessment
- Focuses on one learning progression
- Overlapping forms of a locator test
  - Levels 1 to 3
  - Levels 3 to 5
- No single item will determine a student's level but rather response patterns across a series of items

Brenda bought 20 pieces of candy with 12 quarters. Marisa has 15 quarters. How many pieces of candy can Marisa buy with her money? Explain how you found your answer.

Example	Code

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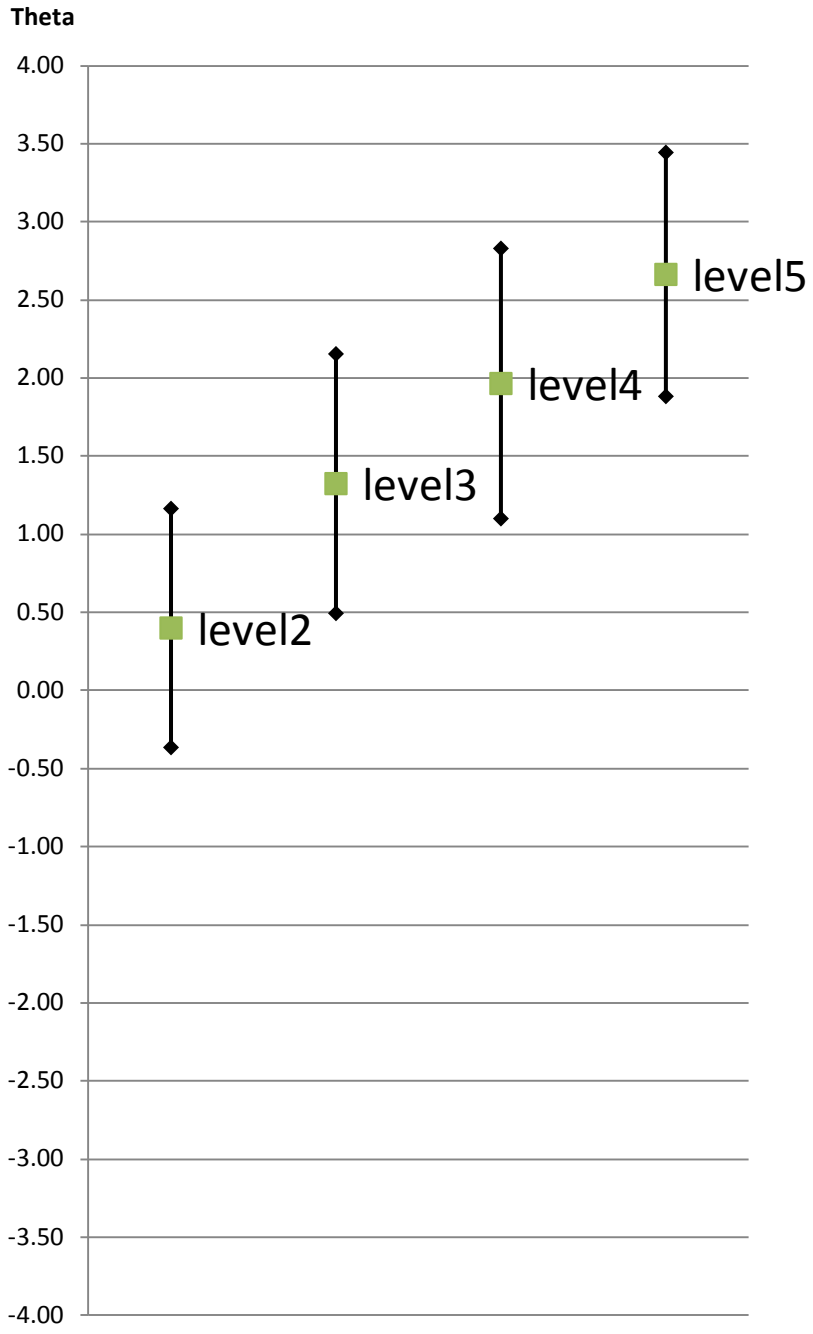
25 pieces of candy. for every three quarters its five pieces of candy so i just added five more pieces of candies	Grouping strategy

Validity Studies

- Expert panel reviews of LPs
- Content analysis and review of tasks
  - Panels of 10 teachers, teacher educators and researchers per progression
  - Judgments of mapping tasks to levels
- Field Study
  - 9000 students
  - Item functioning, measurability of constructs, relation among constructs, form creation



Average difficulty (theta level) and variance for sets of items preclassified at each of the levels of the Proportional Reasoning Learning Progression

Incremental Tasks

- Focus on:
  - One learning progression
  - One transition between two levels
  - One aspect of a transition in some cases

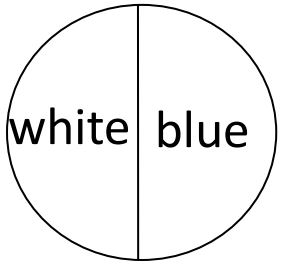
- Straddle the instruction-assessment line

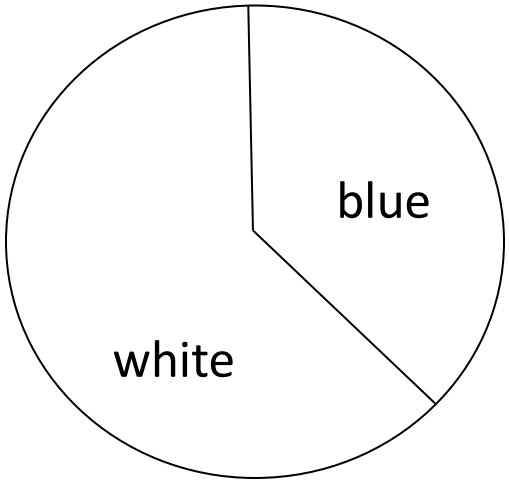
- To be used flexibly in classrooms

Level 1 to Level 2 Transition

From	Intuitive and qualitative comparison of more or less
To	Early attempt at quantifying and understanding the idea of ratio

Level 1 to 2 Incremental Task





Part A

1. When the paint in each pan is mixed, which pan will hold the mixture that is a darker shade of blue? Explain your thinking.
2. Which pan has the greater quantity of blue paint? Explain your thinking.

Level 1 to 2 Task (cont.)

Part B

3. If pan A contains 1 cup of white paint, how many cups of blue paint does it contain? Explain your thinking.
4. What is the ratio of white paint to blue paint in pan A?
5. If pan B contains 2 cups of blue paint, how many cups of white paint do you think it contains? Explain your thinking.
6. Based on your answer to question 5, what is the ratio of white paint to blue paint in pan B ?

How Can the Task be Used?

- With an individual student, small group or whole class
- Students complete a question, share it with group
- As a discussion starter

- To confirm hypothesis of level
- To identify need for instruction
- To identify who is ready for more challenging content

Learning Progressions and LOA?

- Learning progressions are relevant to all agents in LOA
  - Teachers, learners, standards, curriculum, assessment

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Student Self Assessment

Student Self-Assessment Rubric

Exceeds

I can do it without mistakes.

I can help others.

Proficient

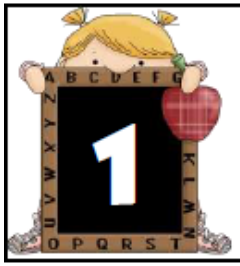
I can do it by myself!

I make little mistakes.

Developing

Sometimes I need help.

I am starting to understand.



Novice

I can't do it by myself.

I don't understand yet.

I can …

- ❑ Read a word problem and correctly identify the ratio
- ❑ Use a variety of strategies to solve ratio problems
  - ❑ Draw a picture
  - ❑ Build-up strategy
  - ❑ Cross-multiplication
  - ❑ Scalar approach
- ❑ Solve problems with more than two ratios

Learning Progressions and LOA?

- Learning progressions are relevant to all agents in LOA
  - Teachers, learners, standards, curriculum, assessment
- Struggled in our work to make the learning progressions accessible to students
- Can we also capture potential language struggles within a topic represented by a learning
  - Discipline specific vocabulary
  - Discourse features
  - Other aspects

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