

Designing Ambitious Mathematics Instruction for English Learners

Architectures for Supporting English Learners across Lessons and Units

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Three Dimensions of Quality



Dimension	Guiding Question
Conceptual Focus	How are central and generative concepts of mathematics the engine for developing procedural fluency and mathematical practices?
Participation by Design	How are English Learners offered multiple, challenging opportunities to participate in mathematical activity with growing autonomy?
Language Focus	How do English Learners develop explicit understandings of how language works as their uses grow more monologic, authoritative, and technical?



What is a Lesson, Conceptually?

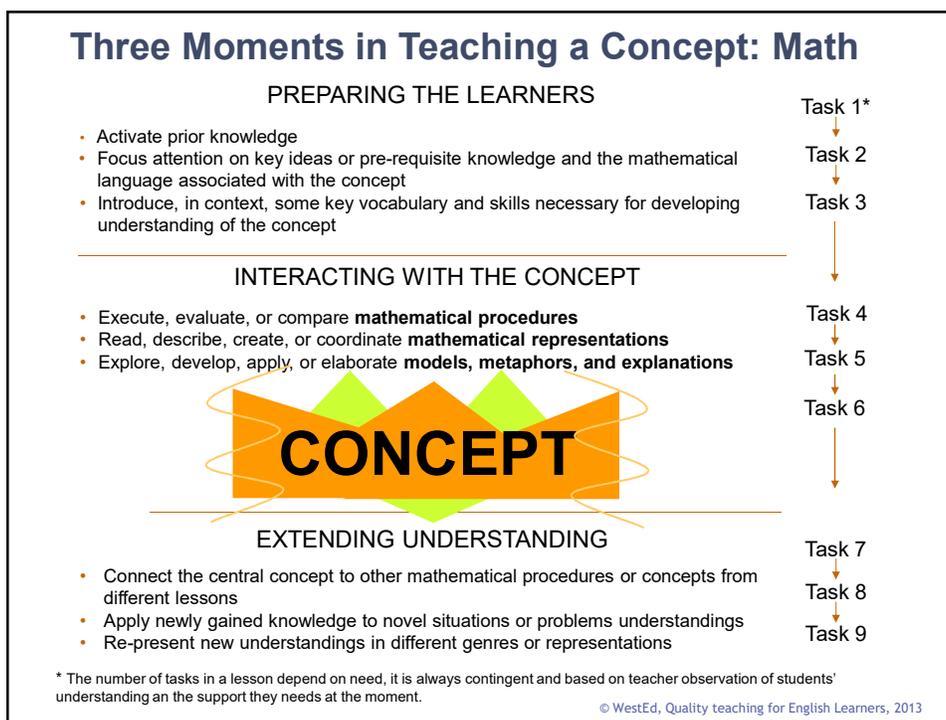
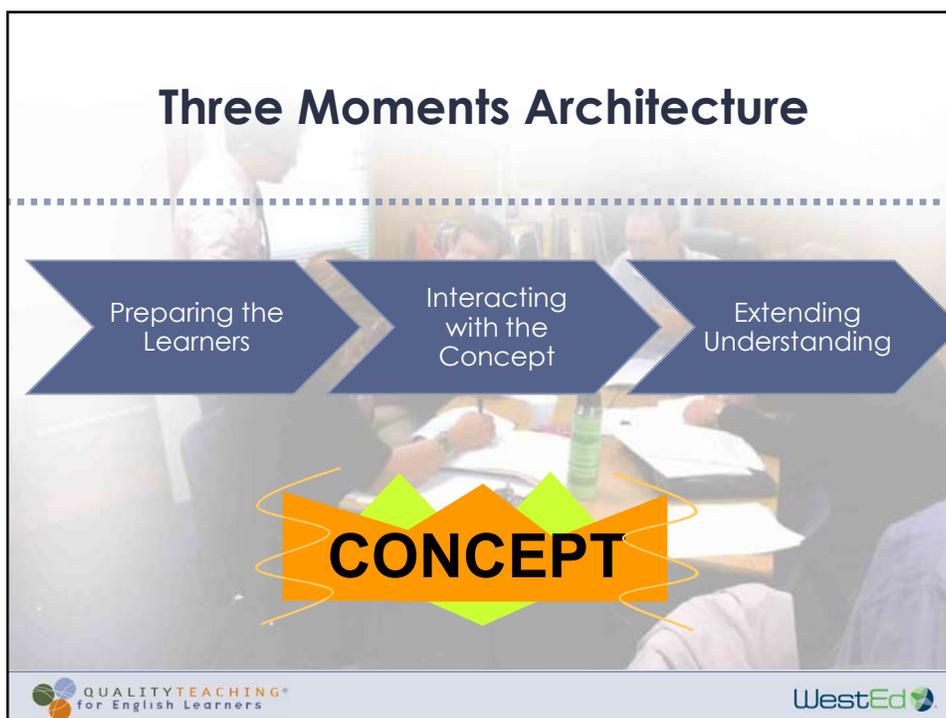


- A lesson is an exploration of a mathematical idea that enables students to make multiple connections.
- Like a narrative arc, a lesson has a beginning, middle, and end (and some degree of tension/suspense).
- To complete that journey, a lesson will usually span multiple class periods or days.

Quality of Lessons in Participation and Language



Dimension	Quality criteria
Participation by Design	As English Learners develop greater conceptual understanding, their participation: <ul style="list-style-type: none"> • Varies across different roles and formats • Becomes more central • Engages with peers of multiple levels
Language Focus	As English Learners develop greater conceptual understanding, their uses of language: <ul style="list-style-type: none"> • Builds on everyday meanings and uses of words • Narrows to more discipline-specific connotations • Allows for growing choices over time.



Backstage Axis

Preparing

Interacting

Extending

Find groups of parabolas with features	Sort and Label
Identify parabolas from sequenced features	Parabola Jigsaw
Match parabolas, factored quadratics, & roots	Read and Do
Connect roots and coefficients to vertex and axis of symmetry	Compare & Contrast Matrix
Explore & evaluate approaches to finding axis	All Four Corners
Extend to non-monic polynomials	Sort and Match
Generalize formula/strategy for axis of symmetry to an arbitrary quadratic	Collaborative Writing

- Connect roots and other symmetrical points to the axis of symmetry.
- Generalize monic quadratics to a general leading coefficient
- Develop a formula for the axis of symmetry of a generic polynomial.

Lesson Exemplar: Remains to be Seen



Conceptual Understandings	Analytic Practices	Language Practices
<p>Students will understand that:</p> <ul style="list-style-type: none"> • Division is a binary operation on whole numbers that yields two outputs, a quotient and a remainder. • The remainder is smaller than the divisor. • Interpreting the quotient and remainder varies based upon whether the situation is partitive or quotative. 	<p>Students will engage in the following Standards for Mathematical Practice:</p> <ul style="list-style-type: none"> • Make sense of problems and persevere in solving them (SMP1). • Reason abstractly and quantitatively (SMP2). • Look for and make use of structure (SMP7). 	<p>Students will use language to:</p> <ul style="list-style-type: none"> • Report the calculational processes and results of solving problems. • Interpret numerical values in real-world situations. • Compare and contrast problem types and solution approaches.



Anticipatory Guide

- Work with a partner.
- Take turns.
- Read the statements out loud
- State whether you agree or disagree.
- Jot down a few reasons for your opinion (ideas, not sentences).



Reading in Four Voices

- Work in a group of four.
- Each member will choose a style of font:
 - plain
 - bold**
 - italic*
 - underlined
- The styles signal whose turn to read it is.
- Taking turns, read the story twice:
 - FIRST, to understand the meaning of the story overall
 - SECOND, to co-create a common representation to illustrate what is going on in the story.

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Read with Mathematics Clarifying Bookmark



- Work with a partner.
- Read your assigned problem out loud.
- Use the Mathematics Clarifying Bookmark to assist your discussion of the key practice *Understand the Problem*.
- FIRST, choose and announce to your partner one of the actions on the left.
- SECOND, select one of the offered pieces of language to use

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Compare and Contrast Matrix



- Work with your partner.
- Together, answer the questions on your matrix.
- Find another pair of students with a different problem.
- Share your answers orally with each other.
- Look across the problems to identify similarities or differences.
- Create a summary statement, using language such as:
These problems have the same...
One difference between these problems is...

Three Moments in Teaching a Concept: Math

PREPARING THE LEARNERS

- Activate prior knowledge
- Focus attention on key ideas or pre-requisite knowledge and the mathematical language associated with the concept
- Introduce, in context, some key vocabulary and skills necessary for developing understanding of the concept

INTERACTING WITH THE CONCEPT

- Execute, evaluate, or compare **mathematical procedures**
- Read, describe, create, or coordinate **mathematical representations**
- Explore, develop, apply, or elaborate **models, metaphors, and explanations**

CONCEPT

EXTENDING UNDERSTANDING

- Connect the central concept to other mathematical procedures or concepts from different lessons
- Apply newly gained knowledge to novel situations or problems understandings
- Re-present new understandings in different genres or representations

Task 1*

Task 2

Task 3

Task 4

Task 5

Task 6

Task 7

Task 8

Task 9

* The number of tasks in a lesson depend on need, it is always contingent and based on teacher observation of students' understanding and the support they need at the moment.

Remains to be Seen

Anticipatory Guide

Read in Four Voices

Read with Clarifying Bookmark

Compare & Contrast Matrix

Create-Exchange-Assess

- Solve story problems involving division.
- Interpret the remainder in context and report a final reasonable answer.
- Connect division strategies to multiplication.

Quality of Lessons

Dimension	Guiding Question
Conceptual Focus	<ul style="list-style-type: none"> How clearly is the conceptual focus defined? How does the conceptual approach tap into students' experiences or funds of knowledge? How rich is the connection potential of the ideas, representations, and procedures in a lesson?
Participation by Design	<ul style="list-style-type: none"> How are activities structured to ensure maximum participation by all learners? How are students offered different roles in interacting with each other? How do these roles support the co-construction of mathematical knowledge? How do opportunities to participate change across time?
Language Focus	<ul style="list-style-type: none"> How are language opportunities structured throughout the lesson? What language supports will students need to be offered to engage in disciplinary practices? How do language practices, grow over the course of the lesson? To what extent do students have greater autonomy in making language choices over time?

Application Activity: Designing a Lesson

- **CONCEPTS:** What are connections will students make across ideas, procedures, and representations?
- **PARTICIPATION:** How will students be offered a variety of formats and roles to participate?
- **LANGUAGE:** When will students need models of language and when will they have greater choice?

Potential Steps to Take



Dimension	Guiding Question
Conceptual Focus	<ul style="list-style-type: none"> • Anticipate students' prior experiences and provide opportunities to make explicit connections. • Identify the minimal "working definition" students need to get in various lesson activities. • Select metaphors or analogies to frame conceptual ideas in ways students recognize.
Participation by Design	<ul style="list-style-type: none"> • Employ different structures for participation to ensure all learners are engaged in sustained oral interactions about disciplinary ideas. • Create opportunities for students to offer opinions and information, but also to converge and reach consensus. • Offer opportunities in which students co-construct through oral interactions.
Language Focus	<ul style="list-style-type: none"> • Provide structured opportunities for disciplinary language practice to develop conceptual understanding. • Map language progressions and identify when to introduce key terms in rich multimodal texts. • Provide formulaic expressions when necessary and attend to degrees of freedom. • Highlight explicit features of language performances as related to disciplinary practices, while giving students substantial latitude.

Jerome Bruner



*“We begin with the hypothesis that any subject can be taught effectively in some **intellectually honest** form to any child at any stage of development”*

(Bruner, 1960, p. 33)

Spiraling

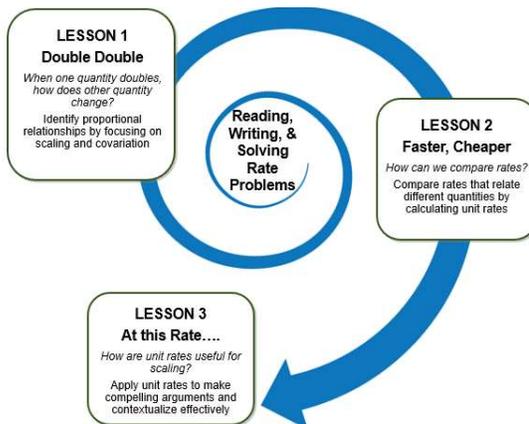
IS NOT

- sprinkling review exercises systematically
- cycling through domains of standards for coverage
- repeating mathematical practices periodically

BUT RATHER IS

- re-tackling old problems with new tools
- connecting ideas across multiple domains
- engaging in mathematical practices adaptively and with greater sophistication

Spiral Architecture of “Getting Great with Rates”



Some Criteria for Unit Quality



Dimension	Guiding Question
Conceptual Focus	<ul style="list-style-type: none"> Organized around central and generative concepts of mathematics Offers an <i>intellectually honest</i> introduction that draws on students' lived experiences. Driven by clear narrative trajectory in which concepts are deepened, revisited/revised, inter-connected, and applied.
Participation by Design	<ul style="list-style-type: none"> Structured opportunities are offered for peer- and self-assessment Across the unit, students are invited to take up multiple and varied roles as they work with more and less capable peers, as well as equally capable peers. Students gradually take on greater autonomy and over time become more central participants in class activities.
Language Focus	<ul style="list-style-type: none"> Offers explicit models for engaging in mathematical discourse. Activities across the unit support students as they engage in more monologic, more authoritative, and more technical uses of language. Students are invited to understand how language works and to use that understandings to make choices.

Application Activity



Take a look at the Unit Overview for “Getting Great with Rates”, a sixth grade, three-week replacement unit on rates created for Charlotte-Mecklenburg Schools.

As you read the overview:

- To what extent do the quality criteria apply?
- What additional information might need to be clearly communicated to the end user?

AMPLIFYING THE CURRICULUM

Designing Quality
Learning Opportunities
for English Learners

Aida Walqui and
George C. Bunch
Editors

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