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Strategies for Supporting English Learners in the Standards for Mathematical Practice

The Verbs of Mathematical Practice

1. **Make sense of problems and persevere in solving them.**
2. **Reason abstractly and quantitatively.**
3. **Construct viable arguments and critique the reasoning of others.**
4. **Model with mathematics.**
5. **Use appropriate tools strategically.**
6. **Attend to precision.**
7. **Look for and make use of structure.**
8. **Look for and express regularity in repeated reasoning.**

An Inspiration

"For English Learners to succeed in learning mathematics, they need to be more *productive* in mathematics classrooms—reasoning more, speaking more, writing more, drawing more."

Maria Santos

Former Director, NYC OELL

Learning Academic Language by Using Academic Language

- "Mathematical concepts, objects, and relationships arise through language, and within particular socio-cultural environments, in response to human thinking about quantity, relationships, and space" (Barton, 2008)

- Learning mathematics involves participation in the mathematical discourse practices in a classroom or other mathematical learning community (e.g., Moschkovich, 2002).

Mathematics Coaching Supporting English Learners (MCSEL)

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Mathematics Coaching Supporting English Learners (MCSEL)

- Develop and study materials to support learning of grades 6-8 mathematics teachers of students who are English learners
  - Materials to guide seminar series for teachers
  - Materials to guide Classroom Inquiry Cycles after each seminar

Mathematics content in the professional development

- Number and algebra word problems
- Geometric reasoning and measurement

Across the materials

1. **Make sense of problems and persevere in solving them.**
2. **Reason abstractly and quantitatively.**
3. **Construct viable arguments and critique the reasoning of others.**
4. **Model with mathematics.**
5. **Use appropriate tools strategically.**
6. **Attend to precision.**
7. **Look for and make use of structure.**
8. **Look for and express regularity in repeated reasoning.**

When number and algebra word problems are the content

1. Make sense of problems and persevere in solving them.
2. **Reason abstractly and quantitatively.**
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

When the focus is geometric reasoning and measurement

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. **Look for and make use of structure.**
8. Look for and express regularity in repeated reasoning.

Key Conjectures about Providing Access for EL Students

- Visual representations will support EL students' mathematical thinking

- Language strategies, integrated into instruction, will support EL students' mathematical productivity

Mathematical Visual Representations

Includes

- *Drawing* (e.g., in enhancing figures in geometry tasks)
- *Diagramming* (e.g., in thinking about word problems and other quantitative tasks)

Hurdles

- U.S. middle-graders generally are not very familiar with mathematical visual representations like diagrams
- Putting language learning together with novel tools like diagramming risks cognitive overload for ELL students

So….

We tapped into cognitive research addressing:

- *Worked examples*
- *Visual representations in mathematics*
- *Minimizing cognitive load*

And we applied research and best practices addressing:

- *Second language acquisition*

Estella's Thinking
-My Tunes-

GOALS

- ✓Get better at making sense of someone else's math thinking.
- ✓Learn how diagrams can show information and relationships to help you solve a problem.

3-Reads

Dario, Aziza, and Cassie bought songs online from My Tunes. Dario bought 45 more songs than Aziza.

Aziza bought 15 more songs than Cassie.

Together they bought 300 songs. How many songs did Dario buy?

1. What is the Problem about?
2. What do you need to find out?
3. What important information is given?

Estella

Step 1

Cassie= C

What do you notice?

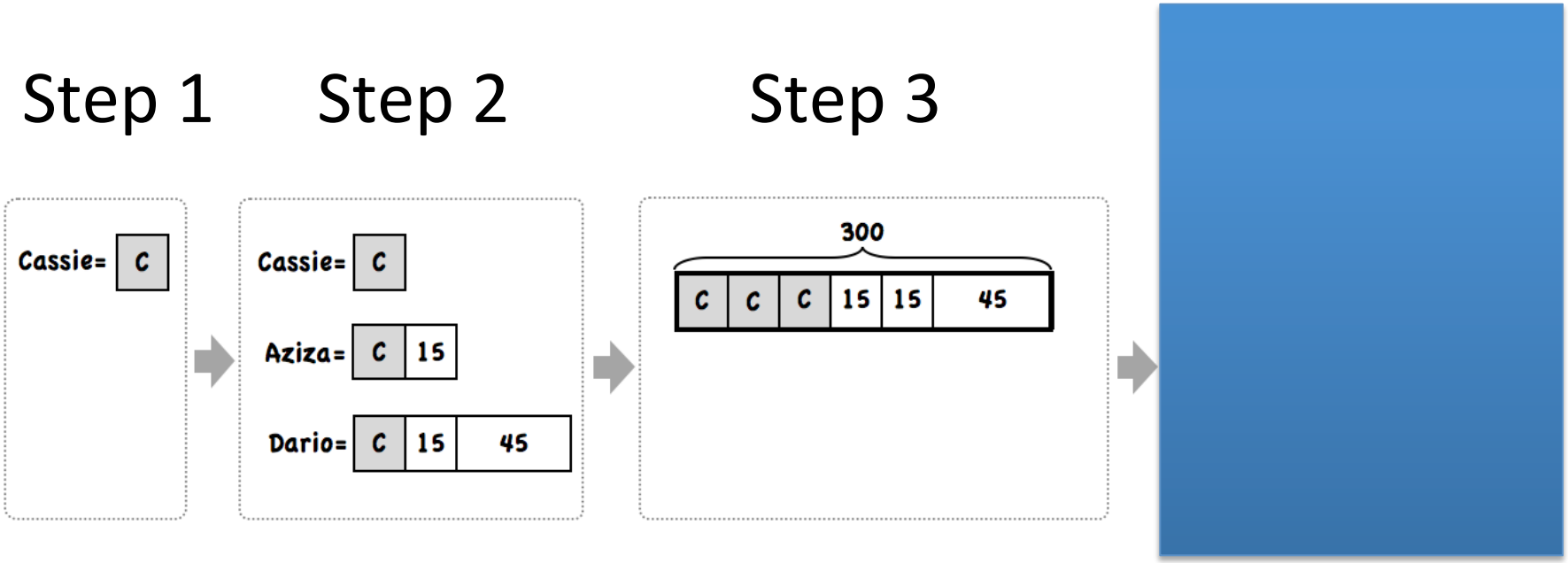
Estella

Step 1 Step 2

What changed from Step 1 to Step 2?

Estella

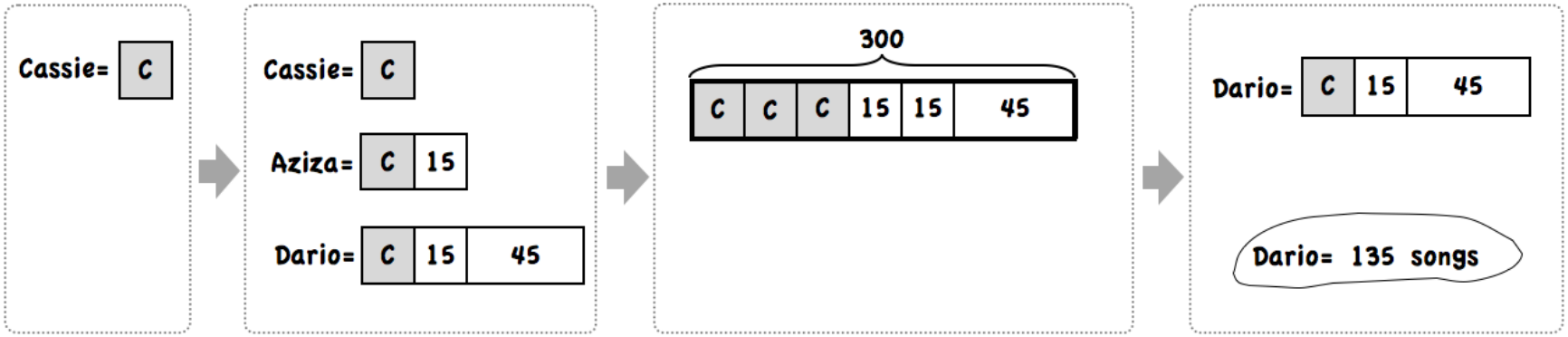
Step 1 Step 2 Step 3



What changed from Step 2 to Step 3?

Estella

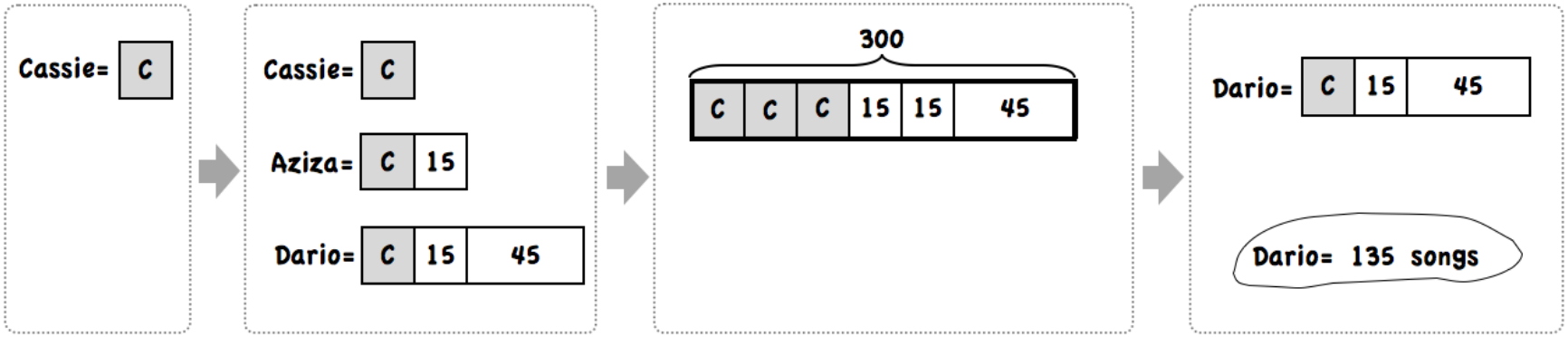
Step 1 Step 2 Step 3 Step 4



What changed from Step 3 to Step 4?

Estella

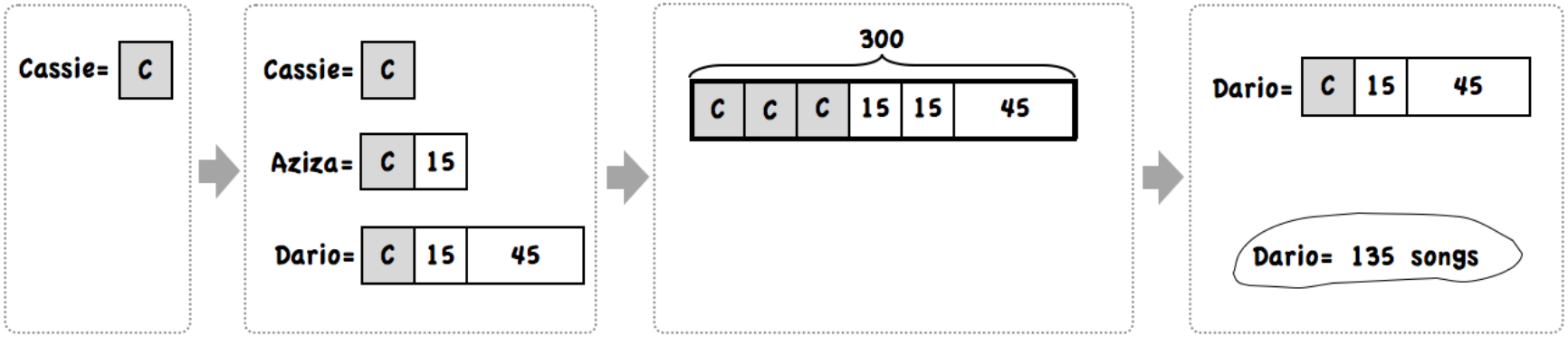
Step 1 Step 2 Step 3 Step 4



I wonder…

Estella

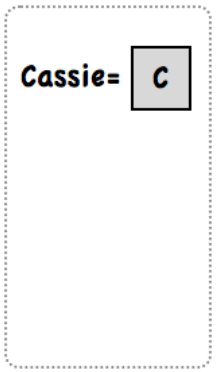
Step 1 Step 2 Step 3 Step 4



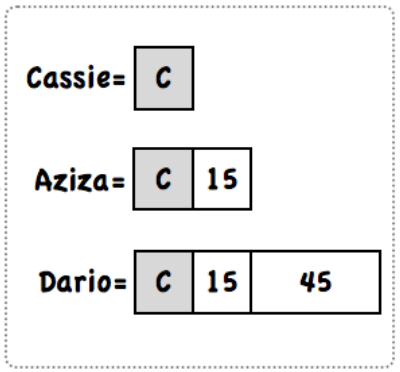
What words will be helpful to describe Estella's strategy?

Estella

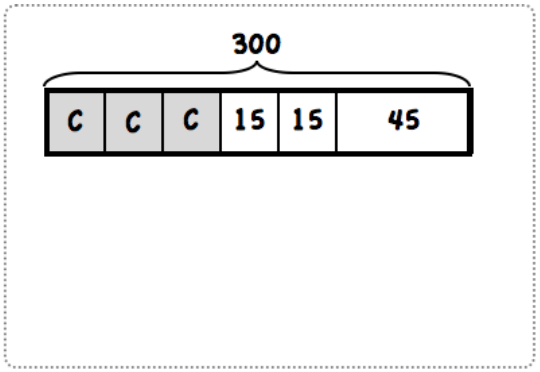
Step 1



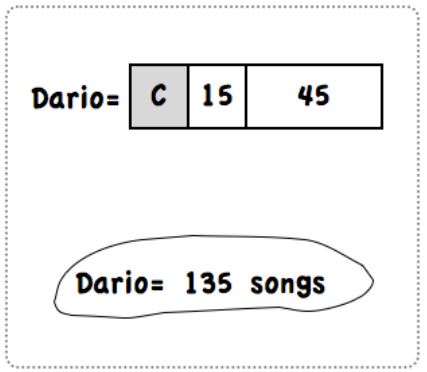
Step 2



Step 3



Step 4



First Next she… Next she…
Finally she… Estella…

Estella discovered…

Write about what you learned

- When representing quantities in a diagram I will…because …
- The next time I create a diagram, I will …. because…
- An important characteristic of a useful diagram is… because…

What was Estella Thinking?

First Estella…

Next she…

Next she…

Finally she…

Estella discovered…

I agree / disagree with…
because…

Analyzing Diagrams Routine

Brief Reflection on Supporting EL Students

- **Diagramming:** How does it support students' diagramming and mathematical reasoning?
  - In what ways does it support the Standards for Mathematical Practice?

- **Language Supports:** How does it support their language access and their language production?
  - How could these supports be used differently depending on the *English proficiency levels* of students?

Supporting Teachers

What is one thing you want to keep in mind when working with teachers about:

1) Engaging ELs in the Standards for Mathematical Practice.
2) ELs' language access and production.
3) ELs' use of mathematical diagrams.

A new website, born of our projects, which we hope will be helpful to you, and hope it will grow and grow:

mathandlanguage.edc.org

Thank you!