Supporting ELs through Mathematical Inquiry and the Discursive Assessment Protocol

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS
CELEBRATING 100 YEARS

Rick Kitchen, University of Wyoming

NCTM 100 Days of Professional Learning Series

Tuesday, July 7, 2020; 7 PM Eastern

UW UNIVERSITY OF WYOMING

Description of session

Introduce the Discursive Assessment Protocol (DAP)

We'll solve a mathematics task or two and view videos of students solving the tasks

We'll have discussions about what you observe in these videos with a particular focus on developing students' (1) mathematical reasoning through discourse, and (2) mathematics register

Reflect on issues related to equity and access

Q & A

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Goals of session

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Participants will learn about **research-based instructional strategies** that benefit EL students

Participants will learn about the **DAP**, an instructional intervention designed to benefit students during problem-solving episodes, particularly EL students

Participants will examine how to use the **DAP** to engage their students in mathematical discourse and meaning making

Participants will also learn about incorporating **deliberate ESL instructional strategies** during problem-solving episodes

Have fun!

Why EL students?

Schools are struggling to meet the needs of **EL students** in the United States (Borjian, 2008; Dong, 2016; Valenzuela, 2005)

ELs largely enter U.S. schools performing below English Proficient (EP) students in core academic subjects (Abedi & Gándara, 2006) and dropout rates for EL students are considerably higher than EP students (Borjian, 2008; Kanno & Cromley, 2013)

Schools experiencing an influx of **ELs** must adjust to meet these students' educational needs (Barrio, 2017; Irizarry, 2011)

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Mathematical reasoning

In the U.S., reforms in mathematics education (NCTM, 1989, 2000, 2014; NGA & CCSSO, 2010) have placed considerable emphasis on students engaging in problem solving to develop mathematical understandings by making connections, communicating, and representing ideas (Hiebert & Carpenter, 1992)

An important goal of engaging students in problem solving is to develop their mathematical reasoning

In the Common Core State Standards (CCSS), mathematical reasoning is so important that it is included in ***three of the eight*** Standards for Mathematical Practice (NGA & CCSSO, 2010)

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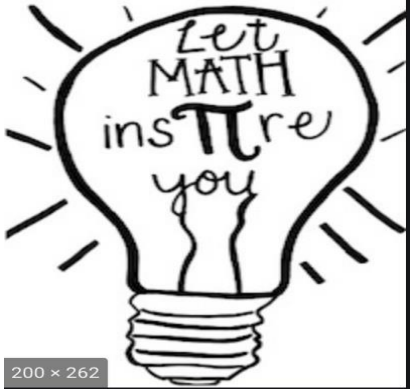
Mathematics register

Academic language has been defined as the linguistic expectations of students to learn, speak, read and write about academic subjects such as mathematics (Valdés, Bunch, Snow, Lee, & Matos, 2005)

Described as words, expressions, and meanings specific to mathematics (Halliday, 1978; Secada, 1992), the mathematics register is the disciplinary-specific reading, writing, listening and speaking norms (Cuevas, 1984; Gutiérrez, 2002)

It is helpful to think of the academic register as a series of resources that promote meaning making, or a set of linguistic features, such as words, symbols, visual images, and grammatical patterns (O'Halloran, 2005; Schleppegrell, 2007)

Attending to mathematics and language



Teachers have generally not been prepared to simultaneously attend to EL students' needs vis-à-vis language and mathematical knowledge (Chval, Pinnow, & Thomas, 2015)

The DAP was designed to help teachers provide students with opportunities to make sense of the language demands of mathematical problems as well as to provide support for EL students to engage in **mathematical discourse** to explain their ideas and to listen to and make sense of the ideas of others

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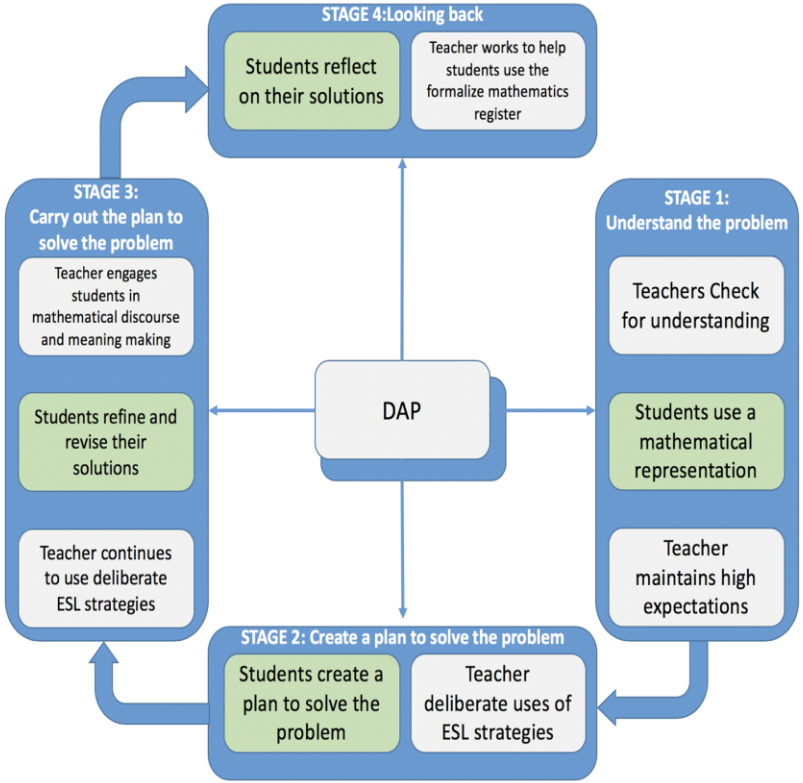
Discursive Assessment Protocol



The DAP integrates Pólya's (1945/1986) classic problem-solving framework with research-based instructional strategies that benefit ELs

The research-based instructional strategies are grounded in theories of academic language development that afford EL students repeated and consistent opportunities to express their mathematical ideas and negotiate meaning with others

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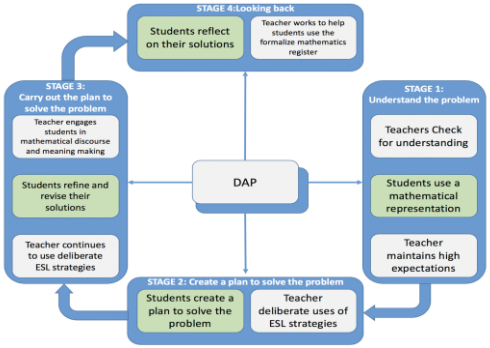
Stage 1 of DAP



Understanding the problem (Pólya, 1945/1986).In this initial stage, students are asked to qualitatively describe the problem context in language that is familiar (Verschaffel, Greer, & De Corte, 2000)

To ensure EL students have repeated opportunities to understand the problem at hand, teachers should ask questions at this stage such as “What is the problem asking you to do?” and “How are you going to figure this out?”

Deliberate English as a Second Language (ESL) instructional strategies are incorporated throughout this stage and all four stages, such as acknowledging and using gestures, integrating cognates, revoicing, and incorporating graphic organizers and mathematical models

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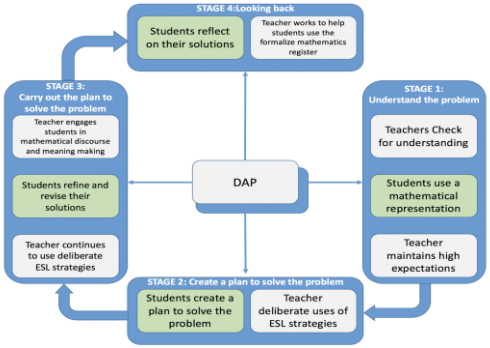
Stage 2 of DAP



Students devise a plan to solve the problem (Pólya, 1945/1986). Among the strategies that students could use to devise their plans include: Guess and check, solve an equation, look for a pattern, solve a simpler problem, use a model, and work backwards (Pólya, 1945/1986)

Working in small groups, students share their ideas with peers and their teacher to get feedback on their solution strategies

Students need support in this stage to develop self-regulation strategies such as devoting time to analyze and plan how to attack the problem similar to accomplished problem solvers (De Corte, 2004; Schoenfeld, 1985)

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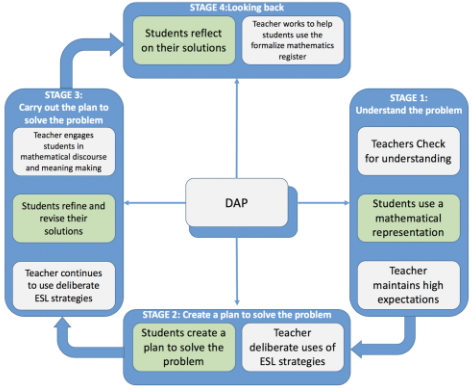
Stage 3 of DAP



In the third stage, students carry out their plan to solve the problem (Pólya, 1945/1986)

Students have opportunities to **share** their mathematical thinking with peers and their teacher through mathematical discourse

A key in this stage is that the teacher asks **meaningful questions** and actively works to highlight and build on students' ideas to support students reflecting on their mathematical thinking and errors (Schoenfeld 1985)

Instruction should leverage ELs' knowledge in their **first language** as a means to help them comprehend a second language (Cummins, 2000)

To support EL students in particular, the teacher "re-voices" students' explanations, references students' mathematical ideas, and asks clarifying questions

The DAP functions as a formative assessment tool, supporting teachers to examine, understand, and leverage students' mathematical ideas and thinking as a means to inform their instruction (Kitchen, 2014)

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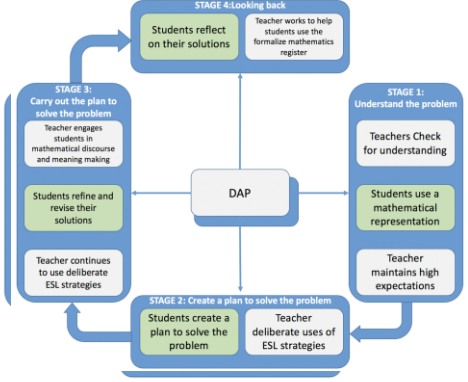
Stage 4 of DAP



In the final stage, students look back at their solutions and check their results

In this stage, the teacher asks: "Does your solution make sense? How do you know? What questions do you still have at this point?"

In addition to reviewing and checking their answers, EL students need opportunities in this stage to **explain** their ideas using the mathematics register

Students are also asked to **write-up** their final solutions, incorporating the mathematics register

Having had time to think about, solve and revise their solutions also means students' anxiety level (Krashen, 2009) has been lowered and EL students may have more confidence explaining their ideas in writing

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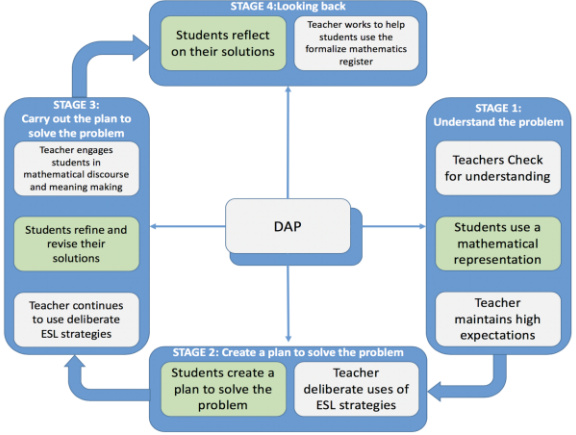
More DAP



The DAP is not intended to be used as a rigid instructional script

DAP is intended to be a tool that provides guidance during problem-solving episodes about how to simultaneously engage students in mathematical problem solving and reasoning through discourse, while meeting the needs of EL students

The DAP is unique in mathematics education. While the Sheltered Instruction Observation Protocol (SIOP) is a powerful tool for rating teachers' instruction vis-à-vis its efficacy for supporting the language needs of EL students and is used to train teachers on instruction that supports the acquisition of academic language (Echevarria, Richards-Tutor, Canges, & Francis, 2011), the DAP provides a framework that is specific to the needs of teaching problem-solving and focusing on language in mathematics

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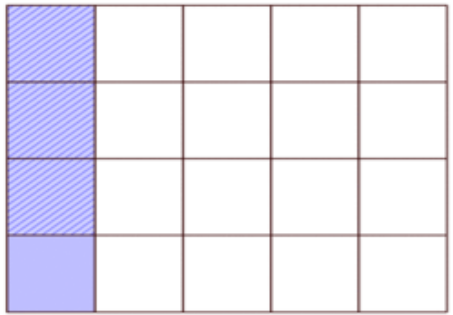
The multiplication story

The diagram represents one whole.



Write a multiplication story that could be solved using this diagram with its two types of shading. Explain how your story context relates to the diagram provided (http://tasks.illustrativemathematics.org/content-standards/5/NF/B/4/tasks/2075).

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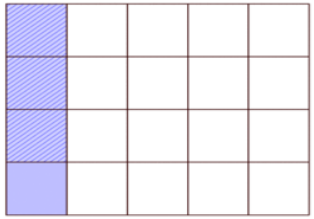

Student videos

Fernando explains his understanding of the task

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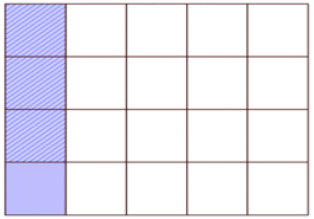

Student videos

Verónica shares her story:

> “The Denver zoo's hippo is going to have a baby. The hippo eats 1/5 pounds of grass every day. The baby will eat 3/4 of that. How much grass will the baby eat every day?”

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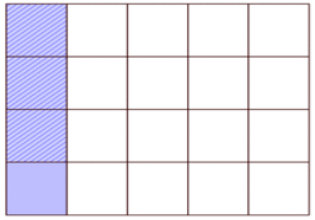

More student multiplication stories

Juana's story:

> "1/5 of the pizza is pepporonie and 3/4 is pineapple how much of the pizza is both pineapple and pepporoni."

Fernando's story:

> "Sam got to play videogames 1/5 of an hour. After he did his homework he got to play 3/4 of the 1/5 that he played. How much does he play after homework?"

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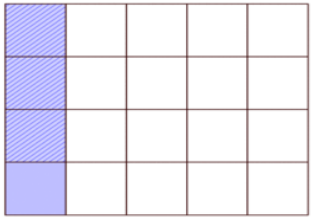

Sentence frames

While Fernando's story is mathematically sophisticated, the clarity of the story could be improved in at least two ways

First, he could modify the second sentence to read, "After he did his homework, he got to play 3/4 of the 1/5 of an hour that he had already played."

Secondly, in "How much does he play after homework?," it is unclear whether Fernando is asking for a unit of time (e.g., hours, minutes) or possibly some number of videogames

To clarify, the question posed could be modified to reference a unit of time. For example, the question could be "How much time does he play after homework?" or "How many hours does he play after homework?"

These potential modifications are examples of sentence frames and explained in the WIDA Standards (Wisconsin Center for Education Research (WCER) (2014)

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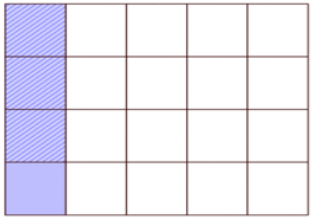

Looking back

This task requires much of students; not only do students need to recognize the notion of **fractions as operators** (Charalambous & Pitta-Pantazi, 2007) inherent in the double shading shown in the diagram, but they also must contend with the **linguistic complexity** (Martiniello, 2008) of writing a multiplication story

Writing a multiplication story that incorporates the notion of fractions as operators requires students to understand the notion of **finding a fractional piece of another fractional piece**

To write their stories, students need to combine the use of everyday language and the mathematics register ("3/4 of 1/5") to demonstrate their understanding (Temple & Doerr, 2012) of how to find the product of two fractional pieces in the problem

Students also need to write a coherent story that most likely concludes with the phrase, "How much" or a similar phrase

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Andres solves task #2

Find ⅙ - ⅔ in at least two different ways

Questions to consider while watching the video:

1. What does the student appear to know?
2. What function does discourse play in this vignette?

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Zenia solves task #3

Andres drove his bike 39 1/6 miles and Ned drove his bike 28 5/9 miles. How many more miles did Andres drive than Ned?

Questions to be considered while watching the video:

1. What does the student appear to know?
2. What function does discourse play in this vignette?

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Marisol solves task #4

Veronica has 5 1/4 pounds of grapes. She gave 2 2/3 pounds to Marisol. How many pounds of grapes does Veronica have left?

Questions to be considered while watching the videos:

1. What does the student know?
2. What do you notice about the mathematical discourse that takes place?

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What does the student appear to know?
What do you notice about the mathematical discourse that takes place?

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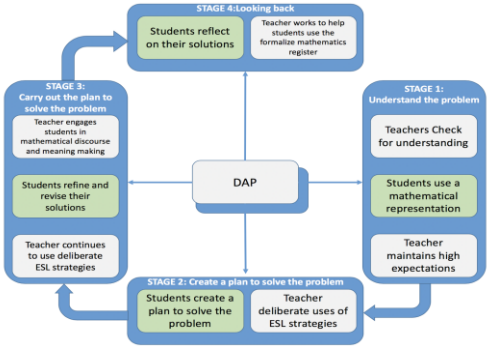
Lessons learned



We learned that while selecting a worthwhile task is necessary to generate student talk (Franke, Kazemi, & Battey, 2007; Silver & Smith, 1996; Smith, Steele, & Raith, 2017), it is not sufficient to guarantee the development of the mathematics register in English

In addition to considering the potential of a task to foster talk, teachers should consider the type of talk that a task may engender

From a language perspective, we are recommending that teachers consider how worthwhile a task is to develop the mathematics register and what aspects of the register the task has the potential to develop

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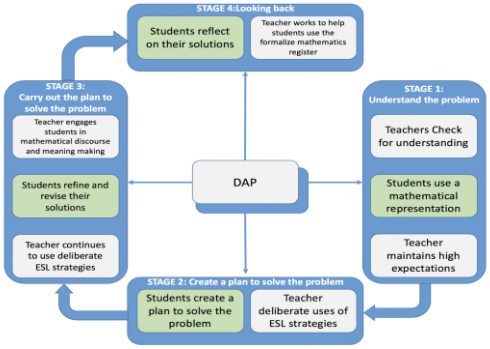
Additional lessons learned



Students are quite capable of inventing procedures and algorithms

Found and addressed their own errors

Discourse helped students discover what they did and did not understand well

Students feel valued when you take their ideas seriously AND their ideas can inform instruction

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Relationships matter

It is important to note that the DAP is significant not just for cognitive reasons, but also because of its potential to support teachers to develop ***positive and impactful academic relationships*** with their ELs and all students (Kitchen, 2014; Kitchen, Burr, & Castellón, 2010)

This is noteworthy given the plethora of examples in the research literature documenting how teachers often struggle to form meaningful relationships with EL students (e.g., see Suárez-Orozco, 1989; Valenzuela, 1999)

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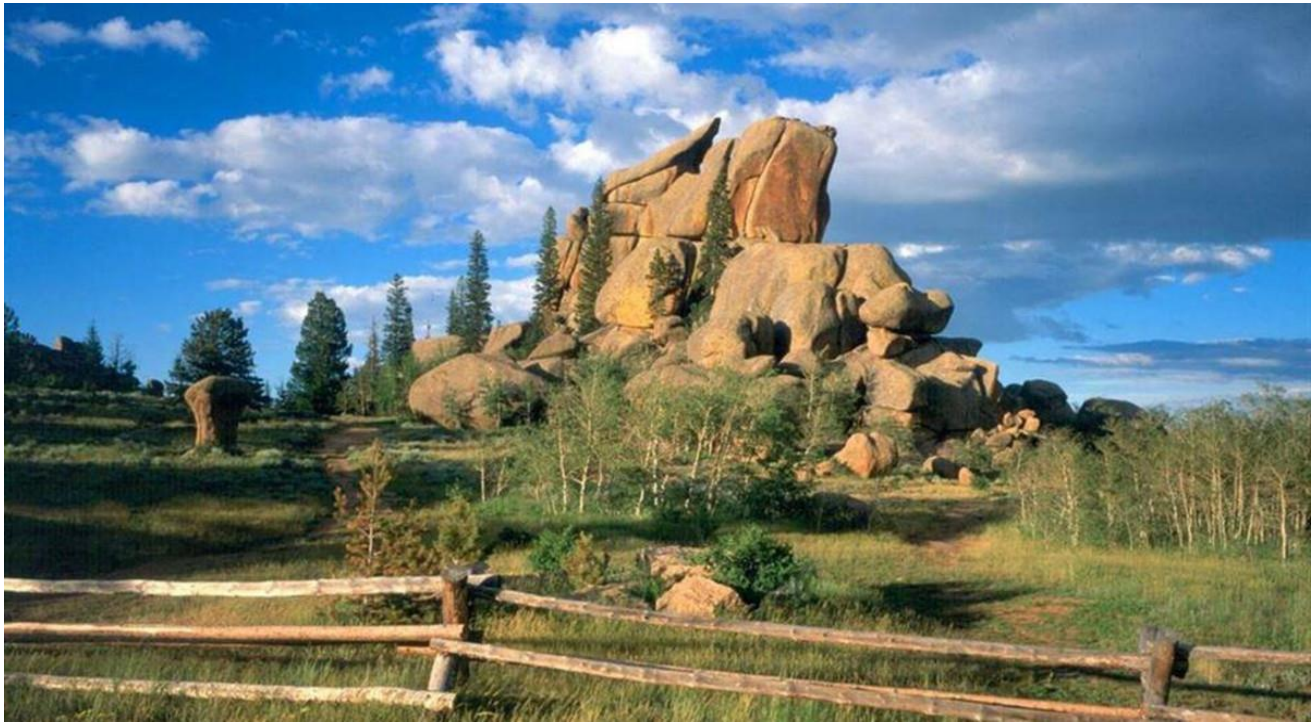
Q & A



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Adelante y gracias!

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