**Teaching Authentic Problem Solving: Developing Greater   
Mathematical Reasoning with Students**

**Objectives**

The goal of this session is to show teachers how they can increase the initiative, perseverance, and eagerness of their students in tackling application problems and help their students develop and apply more sophisticated mathematical reasoning in formulating and solving problems.

**Guiding Questions**

* How can we equip our students to become authentic problem solvers who confidently and patiently reason their way to a solution?
* How can we adapt the application problems we use in classroom instruction to generate mathematical discourse and engage students in productive struggle as they determine what information and methods they need to solve the problem?
* How can we help students learn to ask pertinent questions, develop and justify an effective strategy, and identify the key information they need in solving challenging problems?

**At a Glance**

* “Do Now” activity for teachers listing the challenges students have when asked to complete application problems in their classrooms.
* Discussion of the characteristics that students often display when asked to apply mathematical reasoning and processes to the world around them.
* Presentation and discussion of multiple examples of how we can adapt the application problems we use in classroom instruction to:
  + Generate mathematical discussion
  + Have students themselves determine what is needed and how to complete problems
  + Have students employ (and become comfortable with) different problem-solving strategies

**Materials**

Handout M1 (Teaching Authentic Problem Solving, 6 pages)

**Procedure**

**Set-up:** Open the PowerPoint presentation on a computer connected to a projector and speakers. Project the session’s title (Slide 1). The room should be set up so that teachers can sit at tables in small discussion groups such that each group member can see the screen or smart board where the slides/videos will be projected and hear the accompanying audio.

**Do Now: List the Challenges to the Effective Use of Application Problems (4 minutes)**

Facilitator welcomes teachers as they arrive and asks them to complete the “do now” activity on the first page of the handout.

**Introducing the Session’s Focus: Five Challenges – Which of These Do You Experience and How Might We Overcome Them? (4 minutes)**

* Facilitator summarizes how authentic problem solving taps into the BRACE components of motivation that were discussed in earlier whole-school professional development sessions (Slide 2).
* Facilitator shares five challenging characteristics that students often display when asked to apply mathematics to real life (Slide 3).
* Teachers briefly share their own experiences with these challenges.
* Facilitator introduces the session’s focus: Overcoming these challenges by adapting the application problems we use in classroom instruction so as to generate mathematical discussion, have *students themselves* determine what is needed (and how) to solve the problems, and encourage students to employ and become comfortable with diverse problem-solving strategies.

**Using Images or Extremely Short Videos to Draw Students into Authentic Problem Solving (7 minutes)**

* Facilitator demonstrates how to draw students into focused, authentic problem solving by presenting an image (Slide 4) or a video lasting just a few seconds (Slide 5) that naturally raises a compelling question. (Teachers identify the questions raised: “Which glass of soda would I choose?” “Will the ball go in the basket?”)
* Facilitator uses the soda problem to model the four key questions we need to train our students to ask themselves whenever they encounter a real-life problem that involves mathematics (Slides 6 and 7).

**Helping Students Become Savvy and Patient Problem Solvers by Removing “the Straight Clear Path” We Have Been Providing. (Slide 8, 4 minutes)**

* Facilitator suggests that we often unintentionally limit students’ growth in mathematical reasoning by giving students all the information they need to solve the problem at the beginning, formulating the problem for them, and even signaling the substeps that they might need to follow to find a solution. This common practice also transforms potentially interesting problems into boring exercises.
* Facilitator plays the video excerpt of Dan Meyer’s TED talk describing how we can adapt growth-stunting application problems into ones that are more effective in helping students become savvy and patient problem-solvers.
* Next, the facilitator introduces a sample geometry problem from the PARCC (Slide 9) and demonstrates how to adapt the problem for classroom use to make it more effective in promoting student growth (Slide 10). The facilitator also shares examples of guiding questions that the teachers can use with students to support students’ reasoning as they tackle the adapted problem (Handout p. 4).

**“Is it Too Late?” -- Teachers Tackle an Authentic Problem (9 minutes)**

* Teachers twice watch a 52-second video depicting a real-life paint mixing problem (Slide 11).
* Facilitator displays the four key questions again (Slide 12), and presents a graphic organizer featuring these four key questions -- a useful tool for helping students become more proficient in the problem solving process (Slide 13 and Handout M1, pages 5 & 6).
* Teachers use the graphic organizer (on page 5 of the handout) to formulate and solve the problem, as the facilitator displays the graphic organizer on the screen (Slide 13). Teachers then share their formulation and solution of the problem.

**Using Word Problems in the Classroom to Help Students Develop their Reasoning: Additional Examples (10 minutes)**

* Teachers read a word problem (Slide 15) and then discuss one student’s attempt to articulate what the problem is asking and apply his own method in solving it (Slide 16). Then, the facilitator leads a discussion of how to respond to students’ mistakes and misconceptions (Slide 17). The facilitator then draws teachers’ attention to a planning guide they can use in preparing for a class session that will include authentic problem solving (Handout p. 7).

**Session Summary (6 minutes)**

* Facilitator shares “Key Takeaways” regarding how to teach authentic problem-solving (Slide 18).
* Finally, the facilitator shares two websites that are good sources of authentic problems (Slide 19).