SUMMER PROFESSIONAL DEVELOPMENT

NCTM 2015 Summer High School Institute

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What do we as teachers need to do in order to prepare lessons that will engage our students in the eight Common Core State Standards for Mathematical Practice (SMPs)? The goal of NCTM's High School Interactive Institute is to enable teachers to dive into the lessons and strategies that make for effective mathematics teaching. Through keynote speeches, interactive workshops, and facilitated task discussion groups, teachers have the opportunity to reflect on current and best practices, participate in lessons that they can take back into their classrooms, and work with other educators in their specific content areas on tasks and strategies that will enhance student learning.

NCTM's publication, *Principles to Actions: Ensuring Mathematical Success for All* outlines the role teachers, specialists, and school leaders need to play in supporting mathematics students in the classroom (NCTM, 2014). The High School Interactive Institute brings these principles to life and gives teachers a firsthand experience with implementing the mathematics teaching practices. Participants work on establishing goals to focus learning and implementing tasks that promote reasoning and problem solving. During this process, participants use and connect mathematical representations, facilitate meaningful mathematical discourse, pose purposeful questions, build procedural fluency from conceptual understanding, support productive struggle in learning, and elicit and use evidence of student thinking (NCTM, 2014).

The Geometry Group

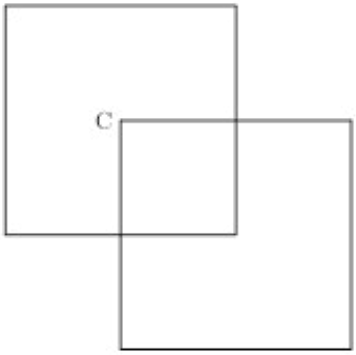
As the geometry task-group facilitators, our role at the institute was a dynamic one. Prior to the event, we worked together to select and prepare tasks that would be useful in communicating the mathematics practices and could be used in a high school level geometry classroom. Preparing the tasks involved considering the best strategy for posing the initial problem. As we did this, we asked ourselves: *What prior knowledge did we want to activate? What would draw students [participants] into the task?* This enabled us to break down each task into manageable pieces that promoted active engagement and discussion. We wanted to allow participants to explore tasks as their students would.

The facilitated task discussion groups met once each day for three days, so that participants could network and unpack their learning from the workshops and keynote sessions that they attended individually. At each meeting, we highlighted the mathematical practices that were the focus for the selected task. Participants worked individually on parts of their task, but were frequently asked to talk at their tables of 6–10 people, or with the entire group, about teaching and questioning strategies for their students. We found it was best to have participants wear their "student hat" and then switch to their "teacher hat" as we worked on each task. This process allowed the participants to actually engage in productive struggle and think critically about how their students would approach a problem and where their frustrations and breakthroughs would occur. While wearing their "teacher hat," participants could consider what kind of purposeful questions they would provide, what help and tools they would offer to their students, and what their "look fors" would be—as evidence for student learning.

Geometry Tasks

The geometry tasks drew upon a variety of NCTM resources including the journal *The Mathematics Teacher*, and NCTM's *Illuminations* website. We also encouraged participants to explore the *Mathematics Assessment Resource Service* website (http://map.mathshell.org) to see what available tasks and lessons could be implemented in their own classrooms. The tasks and SMPs for each day are summarized in the following tables:

Task 1: Rotating Square



This task involves two congruent overlapping squares (*n* units by *n* units). The center of one square is the vertex of the other square. Students [participants] are asked about the shared area if the square with vertex *C* is rotated about *C*. (A full description of the task can be found in *Focus in high school mathematics: Reasoning and sense making in geometry* (King, Orihuela, & Robinson, 2010)

SMPs Emphasized	Facilitating Questions	Connecting to Principles to Actions
SMP 2: Reason abstractly and quantitatively SMP 3: Construct viable arguments and critique the reasoning of others. SMP 6: Attend to precision	*- How would you present this task to your students?* *- How might your students approach this problem?* *- What might students' answers look like?* *- What mathematical questions might arise as they work?* *- How might SMPs 2, 3, and 6 be demonstrated in this task?* *- What are possible extensions for this task?*	Reasoning and Sense-Making *How can students get engaged in the process of Conjecture -> Justification -> Generalization?* *In what kind of meaningful mathematical discourse can students engage?* *What purposeful questions can be posed and how can they be posed?*

Task 2: Soda Cans
Resource: NCTM's *Illuminations* website

SMPs Emphasized	Facilitating Questions	Connecting to Principles to Actions
SMP 4: Modeling with mathematics SMP 7: Look for and use structure SMP 8: Look for and express regularity in repeated reasoning	*- How might your students approach this problem?* *- What might students' answers look like?* *- What mathematical questions might arise as they work?* *- How might SMPs 4, 7, and 8 be demonstrated in this task?* *- How can we get students engaged in this task?* *- What are the multiple entry points?*	*How will you ensure that there are opportunities for reasoning and sense-making by all students every day in class?* *What specific actions will you take during the first few weeks of school to create such a culture in your classroom?*

Task 3: Geometry Tools

For the last task session, we provided a variety of construction tools (straightedge, compass, protractor, Mira™) and asked participants to find as many ways as they could to complete several geometry constructions, such as bisecting a line segment, constructing an equilateral triangle, constructing the center of a circle, etc. The emphasis of this task was on geometry tools and appropriate use. In addition, we spent a significant amount of time on Miras™ - what they are, their use, and how to incorporate them in the geometry classroom. We drew upon the Mira™ activities described in an article in *The Mathematics Teacher* by Powell, Anderson, & Winterroth (1994).

SMPs Emphasized	Facilitating Questions	Connecting to Principles to Actions
SMP 1: Make sense of problems and persevere in solving them SMP 3: Construct viable arguments and critique the reasoning of others. SMP 5: Use appropriate tools strategically SMP 6: Attend to precision	*- For each task, which tool did you find most appropriate? Why?* *- Would you let students choose their tool?* *- How do these tools impact testing?* *- What about technology such as GeoGebra?*	*How can providing different mathematical tools help students learn?* *How do the tools we choose for our students influence their mathematical reasoning and making sense of situations?* *How do mathematical tools help students to communicate and justify their thinking and reasoning?*

Through exploration with tasks, taking part in facilitated discussions, and hearing ideas presented in workshops and speeches, the participants of the 2015 High School Interactive Institute were able to engage in and implement each of the Mathematics Teaching Practices outlined in *Principles to Actions*. As task group facilitators, we not only chose specific tasks to highlight the SMPs, but also paced and structured our sessions so that teachers could both work on the task and think critically about how they would bring these ideas and strategies back to their classrooms.

While we discussed the Geometry group at the high school institute, NCTM offers institutes for elementary and middle grade levels as well as statistics, Algebra I & II for high school level. In addition, the regional as well as annual NCTM conferences provide ample opportunities for teachers to share, discuss, explore, and engage in the teaching and learning of mathematics.

References

National Council of Teachers of Mathematics (NCTM). (n.d.). *Illuminations*. Retrieved from https://illuminations.nctm.org/Default.aspx.

National Council of Teachers of Mathematics (NCTM). (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: NCTM.

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Powell, N. N., Anderson, M., & Winterroth, S. (1994). Reflections on Miniature Golf. *The Mathematics Teacher*, 87(7), 490–495.