Transformational Professional Development:
Teacher Learning Through a Bifocal Lens

Janet Lynne Tassell and Hope Marchionda, Western Kentucky University
Sandra Baker, Allison Bemiss, Liz Brewer, Kathy Read, and Terri Stice, Green River Regional Education Center
Alice Cantrell, Warren County Public Schools
Daryl Woods, Franklin-Simpson Public Schools

In the summer of 2006, the Green River Regional Education Center (GRREC) in Bowling Green, Kentucky, began an initiative designed to strengthen student performance in mathematics through professional development designed to strengthen the mathematics content knowledge of K-8 teachers in the region. We framed this professional development effort as learning through a “bifocal lens.” That is, we wanted participating teachers to learn more mathematics but we also wanted them to be able to think about how they were learning that mathematics and implications for their own teaching practice.

The project, called the Math Alliance Initiative, began as collaboration between GRREC and teams of teachers from 48 schools in 17 districts in the region. During the second year of the project, with additional funding through a 3-year Math and Science Partnership grant, the initiative was expanded to include teacher leaders from these participating schools as well. In total, over 220 teachers and teacher leaders from these 17 districts participated over the four years of the project.

A number of partners played key roles in the project including the Kentucky Department of Education, Western Kentucky University faculty, Global Education Resources, Measured Progress, and Carnegie Learning, with the GRREC overseeing and coordinating the effort. A number of master practitioners from the region who were experienced professional development providers also collaborated with these key partners to design and facilitate the professional development that was offered.

Each year, the project offered a 5-day Summer Math Academy during which participants explored mathematics content with a focus on reasoning and sense making. During the school year, the project offered four full days of professional development that focused on implications for instruction, including the use of instructional strategies that supported mathematical reasoning and sense making, as well as the use of formative assessment strategies that provided more information about what students understood and where they were struggling and implications of this formative assessment data for instruction. An important part of this work also involved becoming more articulate about what we want students to learn at each grade level. The Summer Math Academies and the school-day sessions are described in greater detail below.

Summer Math Academies in Years 1 - 3
Summer Math Academies were planned and facilitated by Carnegie Learning and our designated master practitioners, using pretest and survey data from participants to determine the particular focus of the mathematics that would be addressed. On page 46 is a table that lays out that mathematics content of the Summer Math Academies over the first three years of the project.

These summer academies were designed to strengthen and deepen participants’ understanding of mathematics through the use of problem solving activities that built conceptual understanding and increased procedural fluency using tasks that addressed the specified content. This included exploration of cognitively demanding tasks created by Carnegie Learning that were intended to address the specified
Table 1: Content for Initial Three Years

<table>
<thead>
<tr>
<th></th>
<th>K – 1</th>
<th>2 – 3</th>
<th>4 – 5</th>
<th>6 - 8</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer 2006</strong></td>
<td><strong>Place Value</strong>&lt;br&gt;Modeling for Place Value and Conceptual Understanding of Base 10 System</td>
<td><strong>Place Value</strong>&lt;br&gt;Multiple Representations for Building Foundation of Place Value and Number Sense</td>
<td><strong>Fractions</strong>&lt;br&gt;Build Conceptual Understanding of Fractions and Operations</td>
<td><strong>Ratio</strong>&lt;br&gt;Build the Foundation for Algebra through Ratios and Proportional Reasoning</td>
</tr>
<tr>
<td><strong>Summer 2007</strong></td>
<td><strong>Fractions</strong>&lt;br&gt;Build Conceptual Understanding of Fractions and Multiple Representations</td>
<td><strong>Multiplication</strong>&lt;br&gt;Develop understanding of Multiplication as a Foundation for Algebra</td>
<td><strong>Fractions and Decimals</strong>&lt;br&gt;Conceptually Link Fractions to Decimals within Problem Solving</td>
<td><strong>Proportionality</strong>&lt;br&gt;Connecting Proportional Reasoning with Patterns, Relationships, and Linear Functions</td>
</tr>
<tr>
<td><strong>Summer 2008</strong></td>
<td><strong>Integers</strong>&lt;br&gt;Conceptual Understanding of Integers and Operations with Connections to Algebra</td>
<td><strong>Fractions</strong>&lt;br&gt;Conceptual Understanding of Fractions and Operations with Ratio and Probability Applications</td>
<td><strong>Linear Functions</strong>&lt;br&gt;Using Patterns, Relationships, Representations, and Functions to represent Algebra</td>
<td><strong>Functions</strong>&lt;br&gt;Quadratic and Exponential Function as mathematical tools for Understanding Change</td>
</tr>
</tbody>
</table>

content from an advanced perspective. This also included the exploration of cognitively demanding tasks addressing the selected standards for each grade level of participating teachers and teacher leaders. As a consequence, participants in these academies were able to experience the mathematics content as learners and then were able to bring that experience to the question of how to engage their students in the mathematics content of their grade levels, thus creating the metaphor for learning through a "bifocal lens." Questions of pedagogy were also addressed through the modeling of best practices as staff from Carnegie Learning and master practitioners facilitated summer academy sessions. This attention to pedagogy included explicit discussions about instructional strategies designed to build conceptual understanding and procedural fluency using Teaching student-centered mathematics: Grades K-3 and Grades 3–5 as resources (Van de Walle and Lovin, 2006).

**Full Day School Year Sessions During Years 1 - 3**

For the first two years of the project, participants met with Measured Progress for four full school days to address issues of formative assessment. Participants explored formative assessment strategies including how to identify clear learning targets by unpacking the standards for each grade level and developing "I can . . . " statements (Stiggins, Arter, Chappuis, & Chappuis, 2007) as well as exploring strategies for collecting information about what students were learning, exploring strategies for students to use to track their own learning, and considering how to use assessment data to strengthen instruction. This focus on formative assessment also created opportunities to revisit the use of the cognitively demanding tasks developed for each grade level during the summer academies by considering the particular formative assessment strategies participants might use as students worked on these particular tasks. Because participants were also expected to form and facilitate professional learning communities in their schools, school day sessions during the second and third years of the project provided them with tools to use in this school-based work, including an exploration of the use of protocols for examining student and the use of Japanese Lesson Study protocols. In both cases, the focus continued to be on the use of the cognitively demanding tasks developed during the summer academies as well as the use of other cognitively demanding tasks associated with existing instructional materials.

**Year 4 of the Project**

The fourth year of the project shifted its focus to geometry as a result of finding that many participants in the project appeared to have a limited conceptual understanding of important geometry content. This finding was based on classroom observations of participants as they taught geometry topics, conversations with participants about those geometry topics, and student performance on the geometry strand of state assessments. As a result, the goal of this fourth year of the project was to increase the geometry content knowledge of participants, particularly two-dimensional geometry, as well as helping participants
understand what students needed to know about two-dimensional geometry at particular grade level based on the geometry standards and what cognitively demanding two-dimensional geometry tasks might support the learning of this content.

THE YEAR 4 SUMMER ACADEMY
The Summer Academy for Year 4 was a three-day experience designed to be similar to those of the first three years of the project, creating a situation where participants were again learners of mathematics while also focusing on implications for their own instruction of students, thus continuing the metaphor of learning through a bifocal lens. Academy sessions were planned and facilitated by GRREC, math educators from Western Kentucky University, and master practitioners.

Day One of the Summer Academy focused on a deep examination of the geometry standards, experiencing and designing cognitively demanding tasks that addressed these standards, and considering the kinds of questions it would be important to pose to students as they worked on these tasks. Day One also included a field trip designed to address this geometry content and provide the context for additional geometry tasks. Day Two included learning how to use technology to expand upon the geometry field trip and the exploration of associated geometry tasks in ways that further developed an understanding of two-dimensional geometry while also making connections to the classroom. Day Three focused on strategies for engaging students in these geometry tasks, including the use of differentiated instruction to ensure that all students would be able to enter each geometry task and, though their engagement in these tasks, learn the geometry content specified by the standards. Each day of the Summer Academy is described in greater depth below.

Professional Development Day 1: Geometry Standards, Scaffolding of a Task, Classroom Discourse, Problem Solving, and Field Trip. On Day 1, we began with an introduction asking our participants to consider what they currently teach regarding geometry in their K-8 classrooms. Participants recorded the grade level content on chart paper and, through a "gallery walk" to examine these posters, began to have conversations about what they saw as gaps and repetitions in their current instruction.

Next, participants worked on a geometry task adapted from Carnegie Learning materials, Bridge to Algebra (2008) and Geometry (2008) entitled "Revitalizing Downtown"

FIGURES 1-2: Sample from Unpacking the Standards Document Provided to Participants
that centered around the theme of renovating different aspects of downtown with three Challenges: 1) "Safety Downtown" (Bridge to Algebra, p. 283-286), 2) "Downtown's New Skating Rink" (Bridge to Algebra, p. 305-310), and 3) "Downtown Condominiums, Nature, and Recreation" (Geometry, p. 49-52; Bridge to Algebra, p. 319-320). After working through the "challenges," there was an opportunity to discuss the grade level appropriateness of these tasks, with considerations of how to gear up or gear down the task to the appropriate cognitive complexity to assure access for all children, including scaffolding for those who might need more support and extensions for those who might be ready for greater challenge. There was also an opportunity to explore questioning strategies and "Talk Moves" (Sheffield, March 2006; Chapin, O’Connor, & Anderson, 2003) associated with this variety of tasks.

On the afternoon of the first day of the Summer Academy, participants departed on a field trip to the local downtown square in Bowling Green to explore the project’s version of the "Downtown Math" adapted from the "The Math Connection Opening Your Eyes to Math: Experiencing a Math Trail Through Downtown Elkader" (Horstman, 2000). Participants were divided into six different groups and assigned to two unique architectural locations to complete a geometric scavenger hunt, using digital cameras provided by the project to record their findings. (See Figures 1 & 2 on pg. 47)

Participants completed the Scavenger Hunt and then went on to assigned locations to create two-dimensional tasks specific to the photographs they had taken, thus developing their own local version of “Downtown Math” that could be used with their own students at their own grade levels. (See Figure 3)

Professional Development Day 2: Use of Technology to Expand Upon the Geometry of the Field Trip. The second day of the session involved two breakout sessions. One session focused on the use of Google tools and strategies for incorporating the photographs from the scavenger hunt (See Figure 4) into movies that participants could use for geometry lessons in their own classrooms. Participants
also learned how to use Picasa and Google Docs to embed their own "Downtown Math" tasks (See Figures 5-10) within these movies. The intended outcome was for participants to be able to help their own students develop their own movies using a similar "Downtown Scavenger Hunt."

The remainder of Day Two focused on continuing to strengthen and deepen the geometry knowledge of participants, with a focus on the conceptual underpinnings of many of the formulas used in geometry and the development of the vocabulary of geometry, as well as exploring how the geometry taught at their grade level is a foundation for what comes next. With these goals in mind, participants were asked to work collaboratively on high-cognitive demand task adapted from Geometry: Teacher's

FIGURES 6 & 7: Sample Participant Snapshots for Downtown Math

Teaching thought about asking students determine the mathematical relationships of the shapes in the tile. They also thought about asking students to cut out the shapes and compare them to the pattern block manipulatives.

FIGURES 8-10: Sample Participant Snapshots for Downtown Math

Teachers noticed in the park that depending on the perspective and angle for taking the photograph of the concrete edging of the grass that the angle appeared to be obtuse, right, or acute. They would like to develop problems to help students explore this scenario.
Implementation Guide (Carnegie Learning, 2008; p 7-12) that focused on two-dimensional geometry involving the calculation of the number of gallons needed to seal an octagonal shaped deck without necessarily knowing the formula for calculating the area of any regular polygon. Participants also took part in two “shape sorts” involving a variety of two-dimension shapes that increased in difficulty. After sorting the shapes and displaying the sorted shapes on presentation paper, participants took part in a gallery walk, after which there was an in-depth discussion of the features of these shapes, the names of these shapes, and how these their sorting work related to the geometry content of their grade level.

Professional Development Day 3: Engaging Students in Geometry Tasks with a Focus on Differentiated Instruction. Day Three focused on the use of differentiation strategies for engaging students in the geometry tasks that had been identified for classroom use at particular grade levels, given the geometry standards and “learning targets” for each grade level. This included further discussion of formative assessment strategies, in order to be able to determine what students understood and where they were struggling, as well as how students might be strategically grouped as they worked on these tasks. Our hope was that participants might be better able to discern the extent to which they were actually differentiating their instruction and the extent to which they were appropriately and fluidly grouping students as they differentiated their instruction. They had the opportunity to do a reflective activity called “Where Am I Now?” (Stiggins, et al., 2007) through which participants reflected on their formative assessment practices and prioritized goals for the following school year. This also included worked in vertical teams to discuss how the Curriculum Focal Points for Prekindergarten through Grade 8 Mathematics (NCTM, 2006) addressed two-dimensional geometry at each grade level. Discussions focused how the geometry topics they were currently teaching compared to the Focal Points recommendations.

At the end of summer institute, participants were given a bag of geometry resources that included the following:

- Big Book of Math for Elementary K-6: Read, Write, Research (Zike, 2003)
- Big Book of Math for Middle School and High School: Read, Write, Research (Zike, 2003)
- Navigating through Geometry in Prekindergarten-Grade 2 (NCTM, 2006)
- Navigating through Geometry in Grades 3-5 (NCTM, 2006)
- Navigating through Geometry in Grades 6-8 (NCTM, 2006)

Children’s literature related to geometry given to all participants for use in their school:

- Three Pigs, One Wolf, and Seven Magic Shapes (Maccarone, 1997)
- Where We Play Sports: Measuring the Perimeters of Polygons (Roza, 2004)
- Spaghetti and Meatballs for All! A Mathematical Story (Burns, 1999)
- The Greedy Triangle (Burns, 1997)
- Sir Circumference and the Dragon of Pi (Neuschwander, 1999)
- Sir Circumference and the Round Table (Neuschwander, 1997)

Our hope was that participants would now have the resources to strengthen the teaching and learning of two-dimensional geometry at each grade level so they could now facilitate conversations about this content with colleagues in their professional learning communities about the alignment of geometry topics at each grade level and across grade levels and how to use these resources to better differentiate their geometry instruction at each grade level.

FULL DAY SCHOOL YEAR SESSIONS DURING YEAR 4

Participants continued to meet for four full days during the school year during this last year of the project, now with a focus on the CCSS standards for geometry, the use of cognitively demanding geometry tasks, and strategies for differentiating instruction. As in prior years, participants were also expected to organize and facilitate professional learning communities in their schools where what was learned through the project could be shared with colleagues. And action plans for strengthening mathematics teaching and learning could be developed.
Conclusion
The purpose of the Math Alliance Project was to provide an opportunity for teachers to deepen their conceptual understanding of mathematics as learners while also creating opportunities for them to strengthen how they teach mathematics to their students. It is our hope that teachers who participated in this project not only now have a stronger mathematics teaching practice but are also better prepared to support colleagues as they endeavor to strengthen their mathematics teaching practice as well. (See Figure 11) Roger Lewing says, "Too often we give children answers to remember rather than problems to solve." What we want is an education that teaches us how to think rather than what to think. We hope the teachers who participated in our project are prepared to be teacher leaders who do just that!

FIGURE 11:
Teachers Pondering Problems for Own Version of “Downtown Math"


References


Sheffield, L. (March 2006). Developing mathematical promise and creativity, *Journal of the Korea Society of Mathematical Education Series D: Research in Mathematical Education*.


