While most teachers are aware that professional development can be much more than one-shot meetings, many still struggle to find the time to do something different. What does “different” look like, and how does one find the time to do it? How much time and effort will be required beyond our regular workday? We found deep learning on the part of both teacher and student was not as difficult to achieve as we had anticipated when we teamed up with fellow mathematics teachers and followed some basic principles. This story of learning and growth comes from our work as members of a professional development team (PDT), an outgrowth of the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM). PDTs are formed as a merger between mathematics teachers within a school or district, one or more preservice mathematics teachers from a local college, and the preservice teacher’s university supervisor. We operated under the assumption that there is no dichotomy between preservice teachers and in-service teachers but that preservice and in-service teachers reside at different places on one professional development continuum. In this framework, the opinions and experiences of the preservice teacher are valued as much as those of the in-service teachers. The preservice teacher, in turn, must recognize the richness of the experience of the in-service teacher. The focus of the PDT is the preservice and in-service teachers’ mutual goals.
of (1) having students master mathematics and (2) moving along the professional development continuum by working and learning together.

Telling the entire story of our work on the professional development team would take a book rather than an article, so we offer it here as three PDT Principles. The first two principles are related to the activities of our PDT over the first two years: (1) Only work on a goal that all of your PDT members see as central to their work and (2) Smaller goals can lead to greater gains. The third principle, Real change occurs one lesson at a time, is connected to the story of the PDT’s third year and to the experience of a lesson study action research plan initiated by our preservice teacher.

**PDT PRINCIPLE #1:**

*Only work on a goal that all of your PDT members see as central to their work as mathematics teachers*

Principle #1 can help solve one of the perceived difficulties of a PDT: time constraints. Are students struggling with solving systems of linear equations? Are they struggling to be motivated in all mathematics courses? Is our aim to have more students enrolled in four years of high school mathematics? Whatever the goal, it must be focused on the students. In our case, the PDT instantly agreed on what was needed: a shared vision of curriculum. In fact, teachers were not always sure what was happening in the room next door, even if the same course was being taught. We assumed that we knew, but every once in a while we would hear about a lesson or activity that made us wonder. Hence, the team decided to learn about curriculum and to engage in creating and teaching such a curriculum.

How did this effort address the perceived time-constraint difficulty associated with PDTs? As a result of our common goal, we realized we did not need to seek much additional time because the goal was something we were already going to pursue. What changed was that we would coordinate our efforts and work together more frequently, thus streamlining the process.

In year one, the team began to meet once a month to discuss curriculum issues. Highlights from that first year included a teacher’s trying out a unit from the Integrated Mathematics Program (IMP), a curriculum based on the NCTM Standards, which incorporated “The Pit and the Pendulum” by Edgar Allan Poe. We chose this unit to sample an integrated curriculum because it is similar in structure and method to Connected Mathematics, which had been used for a few years in the middle school. This unit was quite different from the textbooks used in the past. It made connections, not just between mathematics concepts, but also between mathematics and literature. Twice-monthly meetings focused on the impact the story had on students and teacher in terms of instruction and assessment. Students were challenged to think for themselves, and the teacher, as well as the students, had to make adjustments. The teacher had to allow students to struggle and had to encourage them to answer their own questions whenever possible. The teacher also had to allow more time for in-class work as well as for discussion—time that had previously been devoted to lectures or working examples. Teaching this unit prepared us for the idea that there was a lot to learn when implementing an integrated curriculum.

The following summer we met on four days in June and July, and we also met at the beginning of the school year. The idea was to produce a rough draft of a curriculum that was both integrated, emphasizing connections within mathematics, and coordinated, with one course/year leading to the next with little overlap. We had decided not to be guided by a textbook, because no available integrated textbooks were written specifically for the Tennessee state standards. We began by separating all of the standards from sixth grade through algebra 2 into content strands.

The standards for each grade/course had five content areas: number and operations, algebra, geometry, measurement, and data analysis and probability. We examined each strand separately at first, looking for when a concept/procedure was introduced, when it was extended, and when it was repeated. We made decisions within each course as to whether the standard should be a complete lesson or a secondary lesson, or whether it should just be brought up again as homework to retain student skills.

After each content strand was completed, we pulled the course standard back together. The next project was organizing the standards within the course. We read the standards aloud to each other and decided which ones fit naturally together. We discovered that content strands are not the most natural organizing feature. Our end products were more integrated, although most units had a predominant content strand. We set up spreadsheets for each course in order to track what had been taught and what texts or materials had been used and to note changes suggested for next time. The idea was to connect across content standards by integrating as much as possible. As figure 1 indicates, the spreadsheets began as a list of content objectives from the state standards, grouped on the basis of natural connections we had identified. The spreadsheet format allowed for ongoing changes as the units were implemented, as decisions were made about what to group...
on a particular day, what activities to use, and what assessment tools to include, enabling us to shift components among units more easily.

The second year, teachers set out to implement this new curriculum and quickly found it to be an overwhelming task. The curriculum, as we arranged it, had no set text. In fact, most teachers were using more than one text. Poor student skills were our greatest challenge. One of the basic ideas we had agreed upon was to avoid unplanned overlapping of courses/years, but we found that we continued to feel the need to review material from previous years. We knew some content would need additional work, especially in the first year of the project, but we did not anticipate how much time would be required. This threw our timing off quite a bit. As a result, teachers mainly fell back to a position of doing what they had always done while trying out a few more integrated activities.

The following summer, we took a fresh look at what we had planned and decided that we had bitten off more than we could chew. The result had been more of the same kind of curricular inconsistencies and redundancies. The difference was that everyone knew better and was dissatisfied. Upon reflection at that point, we had learned (a) the mathematics that everyone else thought was important, within the team and within our state, (b) how the curriculum that we had been teaching matched up with the Tennessee standards, and (c) just how much work it is to coordinate a curriculum over several years/courses. The greatest benefit was the increased communication among the mathematics teachers on our team. The time we were spending on this project had increased only a little, but our ongoing conversations were now more focused. This led us to Principle #2.

**PDT PRINCIPLE #2:**
*Smaller goals can lead to greater gains*

In an effort to keep our goal manageable, the decision was made that we would focus only on algebra 1. This course is seen as a flagship course; all students are required to pass an end-of-year state assessment on this subject. Algebra 1 was also a good choice because each teacher, no matter course or grade level, taught objectives related to those of algebra 1. This decision allowed us to zoom in,
focusing on how to develop a unit on the go. That summer we took a fresh look at the algebra standards and how to group them into naturally connected clusters that would become units.

The following school year, our monthly meetings focused on implementation issues around the algebra 1 units and on developing anchor activities. An anchor activity is a lesson or project that will tie most of the objectives for the unit into one nice package. One anchor activity we used was to have students measure the steepness of ramps in and around the school building. Students walked up and down the various ramps to feel their steepness, measured their rise and run, and sketched them on a graph to compare. These activities formed a foundation for the remainder of the unit on linear functions, providing not only graphs but also experiences to use as benchmarks to understand slope and intercept. The need to develop an anchor activity for each unit fit well with the university’s teacher preparation program, which requires each preservice teacher to complete an action research project in a lesson study format. Principle #3 is an outgrowth of the experiences of our preservice teacher, Brandy Ferrell, as she completed her action research project.

PDT PRINCIPLE #3: 
Real change occurs one lesson at a time
The research conducted during the third year of this program involved the concept of lesson study within the PDT. In this lesson study, four members of the PDT collaborated to research, compose, teach, reflect upon, and revise a single lesson as determined by the needs of our students. When we decided to implement the lesson study, we chose a mathematics topic that was common to each teacher’s curriculum and a concept in which students had encountered difficulty in previous years. By focusing on an introductory lesson on functions, we hoped to provide students with a better understanding of why we study algebra. We were interested in providing a means of motivation for the algebraic manipulation and graphing with which students had previously struggled. Because our focus as a PDT had been algebra, performing a lesson study on this topic fit well with our PDT work and fulfilled our goal to create an anchor lesson for a specific topic in algebra. The role of the preservice member of the PDT included the facilitation and implementation of the lesson study as well as the analysis of the outcome of using the lesson study process.

After reviewing research on curriculum, instruction, and assessment issues involving the function concept, we developed a lesson for implementation in one seventh-grade prealgebra class and two high school Foundations II classes. The key ideas we addressed, as determined by the literature review, included studying data relevant to student interests, connecting various representations of functions, illustrating with metaphors, and focusing on the concept rather than the algorithm. To make the lesson relevant to student lives, we allowed them to find examples of functions in the newspaper. The students pursued this activity with interest and enthusiasm, and it provided a method for assessing their understanding of the function concept. Only after developing students’ concept definitions and introducing a variety of representations of functions did we introduce the symbolic form of this concept. After each stage of the lesson study, we met to evaluate, reflect, and revise based upon the results of the lesson. Because of the success of each lesson attempt, only minor changes were made to the lesson between each stage of the lesson study. Assessment data indicated that the students understood the concept much better with this approach than they had with lessons used in previous years, and student performance on algebraic manipulation and graphing improved after the introduction of functions in this class. This indicated the importance of researching teaching strategies for certain concepts and planning lessons as a team prior to implementing lessons in the classroom.

By using the lesson study process, we have discovered some effective teaching methods that have had a positive impact on our team. Lesson study not only has helped us grow as individual teachers but has also assisted us in uniting as a team and aligning our algebra curriculum across our middle and high school courses. Because of the extent of research and collaboration required in a lesson study, this project has been an incredible instrument for pulling together the coursework for the preservice teacher and aligning it with her role as a preservice member of the PDT. The lesson study has also provided a resource for future teachers to use when teaching the function concept, and it has given them a true team experience to duplicate as they join other professional teams in the future. The preservice mathematics teacher member of the PDT would encourage all other teaching professionals to participate in lesson study, for educators should constantly strive to improve teaching strategies, and lesson study is an invaluable tool for doing so.

The PDT’s impact on the teacher preparation program at the University of Tennessee is both personal and practical. Since one of the major focus areas in a teacher education program is curriculum, working within the ACCLAIM PDT on curriculum alignment complemented the preservice teachers’ coursework and better prepared them for a career as a teacher. Brandy Ferrell, the UT preservice member in the final year, found that her involvement in the professional development team allowed her to experience firsthand the act of determining where
and how to implement algebra 1 standards best. According to Ferrell,

UT’s program introduced me to important issues in education and the many theories about how students learn, but I found that I was lacking in actual “real” applications related to the classroom, such as the designing of curriculum. As we examined the standards of an entire course and found how they related to each other, I realized how those standards could be aligned to provide a relevant context for students to learn mathematics. This introduction into curriculum matters provided a framework for the research I conducted while completing my teacher preparation program.

CONCLUSION
Our professional development team started with the common goal of a cohesive, coordinated mathematics curriculum (Principle #1). We began to find tangible success when we narrowed our focus to a single course, developing units and anchor activities (Principle #2). Significant change in practice came when we shifted our focus to a single lesson (Principle #3). This placed our daily planning in the larger context of a coordinated curriculum, which enabled us to learn lessons about mathematics teaching in general from studying a specific lesson.

Following the basic principles presented here can take many different forms. The professional development team merely offers one variation of the kind of structure that can lead to successful professional development for mathematics teachers. PDTs offer practicing teachers the help of a local professor and the energy of a preservice teacher. The preservice teacher benefits by observing that what the professor has been sharing truly can be applied in the classroom, and the professor can use these experiences to coach future students better as they learn how to teach. The mutual benefits to the various educators involved in the PDT allow us to improve upon the most important aspect of our careers: the education of our students. ∞

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