



# PRINCIPALS + ALGEBRA (- FEAR) = INSTRUCTIONAL LEADERSHIP

By Cynthia L. Carver with Michael Steele and Beth Herbel-Eisenmann

**W**e were nearing the end of our series of principal study group sessions, and a small group was reflecting on what they had learned. That's when Diane Meyers, principal at an area middle school, spoke. She started out softly, but her voice grew louder and stronger as her private experience became public. "This study group

has been really good for me as a leader. I am more confident and clear about my vision for improving algebra instruction in the building, and I can talk about algebra with our teachers. But it's also been really scary. You might not believe this, but as I drive over here and anticipate what we are going to do each session, I break out in hives! I haven't solved math problems since I was in high school, and that was 20 years ago."

As one of the group's facilitators, I was not entirely sur-

prised by the revelation of Meyers (a pseudonym). It has been a long time since I had worked through middle school algebra problems, too. But her words suggest a deeper transformation that came from engaging in a deep and sustained learning of mathematics content. As a result of participating in the project, Meyers now knows what she wants to see teachers and students doing in an algebra classroom. She knows how to listen for student thinking about mathematical ideas, and she can identify the teacher moves that elicit such thinking. Moreover, she can (and does) have substantive conversations about mathematics with teachers.

Recent state legislation in Michigan mandates that all graduating seniors successfully pass algebra I and II. Numerous initiatives have been enacted to help mathematics teachers meet this challenge, yet school principals have had little preparation for the necessary curricular and instructional changes. To address this unmet need, we, as university-based facilitators, designed and tested a series of eight algebra-intensive sessions for secondary principals in six surrounding school districts in south-central Michigan. In recruiting participants, we were especially interested in attracting leaders, such as Meyers, without mathematics backgrounds.

Unlike at typical workshops, principals in the study group (with sessions that ranged from two to four hours in length) had opportunities to regularly solve and discuss algebra tasks commonly used in middle school, read and watch video of teachers implementing similar tasks in their classrooms, analyze student work around those tasks, as well as identify and talk about teaching practices that support meaningful student-centered learning in mathematics (see Smith, Silver, & Stein, 2005; Stein, Smith, Henningsen, & Silver, 2009). Importantly, our principals sustained this level of intensity across five short months, racking up more than 30 hours of quality professional learning.

Guiding our work was the construct of leadership content knowledge (Stein & Nelson, 2003), which argues that effective instructional leaders need a deep and flexible understanding of at least one subject area, including how it is best learned and taught, in order to effectively assess teacher performance and guide teacher development. Knowing that few principals have ex-

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## LEADERSHIP MOVES FOR ALGEBRA TEACHING

Algebra teaching	Potential leadership moves
LESSON PLANNING	
A teacher's selection of mathematical tasks has critical implications for what students can learn.	<ul style="list-style-type: none"> <li>• Encourage a vision for algebra that puts an emphasis on mathematical reasoning.</li> <li>• Reassure teachers that time spent on high-level tasks will be rewarded.</li> <li>• Help teachers secure needed curricular and instructional resources.</li> <li>• When observing in the classroom, pay attention to the cognitive demand of selected tasks.</li> </ul>
LESSON DELIVERY	
A teacher's skill at facilitating discussion around mathematical tasks, including the questions asked, has critical implications for what students can learn.	<ul style="list-style-type: none"> <li>• Acknowledge teachers for engaging students in discourse around the big ideas of algebra.</li> <li>• Assist teachers in learning how to become more skilled at facilitating discussion-based classrooms.</li> <li>• When observing in the classroom, pay attention to how questions get asked and how discussions are facilitated.</li> </ul>
A teacher's willingness to allow students time to muddle through problems together has critical implications for what students can learn.	<ul style="list-style-type: none"> <li>• Acknowledge the trade-offs that come from devoting time to high-level mathematical problem solving with teachers.</li> <li>• Help teachers manage the press of state content standards and benchmarks by clarifying local expectations.</li> <li>• When observing in the classroom, track student engagement with the task.</li> </ul>
ATTENDING TO STUDENT THINKING	
Teaching for conceptual understanding requires that we listen closely to student thinking.	<ul style="list-style-type: none"> <li>• Support and encourage the collaborative analysis of student work by teachers.</li> <li>• When observing in classrooms, pay attention to teacher-to-student talk and student-to-student talk.</li> </ul>

perience teaching algebra, and many more principals lack recent teaching experience, this seemed the appropriate starting point. To help students and teachers succeed at reaching new graduation requirements in algebra, we were convinced that principals would need a foundational understanding of algebra and how best to teach it.

As program developers, we were especially interested in Stein & Nelson's (2003) notion of "post-holing," which argues that all leaders benefit from an in-depth exploration of representative slices of subject areas in which they are not familiar. Our intent with this project was to provide principals with a substantive experience "in which they experience what is like to be a learner of that subject (algebra), in which they study what is known about how children learn that subject and become familiar with the best instructional methods for that particular subject." Ideally, principals would then transfer what they learned into other mathematics classrooms and even other subject areas. As Stein & Nelson (2003) elaborate:

From knowing a single subject well, administrators will bring to their exploration of the second and third subjects the recognition that every subject has its own domain of exploration, its

own criteria for inquiry, its own rules of evidence and argument. They will bring their knowledge that the primary learning task is for children to be building knowledge of the central knowledge structures and modes of inquiry of each subject and that it can be predicted that some ideas will be more difficult than others for many students (pp. 433-444).

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To develop principals' mathematical knowledge for algebra teaching, we focused the study group sessions around three big ideas: how algebra can be conceptualized as the study of patterns and functions; the ways in which algebraic reasoning can be developed through tasks of high cognitive demand; and the important role of representing algebraic ideas and translating among representations in the teaching and learning of algebra. Ultimately, we hoped that post-holing of this sort would prepare principals to engage with staff in rich and substantive discussions around the teaching and learning of algebra, and around the improvement of algebra instruction in their buildings.

What did our principals learn from this experience, and how is it changing their practice as school leaders? Three key observations stand out. First, principals are now better positioned to observe standards-based algebra instruction. Second, principals are more comfortable talking with teachers about what they saw and what they hope for in algebra classrooms. Finally, the experience of being a learner helped many of our principals to identify with those students who often struggle in the algebra classroom.

## OBSERVING IN A MATHEMATICS CLASSROOM

The study group offered principals an opportunity to revisit content that they had not seen for many years and to understand that content in an entirely new way. From a technical perspective, principals were routinely exposed to algebra-specific terminology, problem-solving techniques, and instructional practices. They were introduced to new instructional resources that supported student learning, such as algebra tiles. They also became better acquainted with middle-school algebra content and the state-level standards linked to that content. This technical knowledge enhanced principals' ability to act responsively when observing algebra instruction. As one participant explained, "The principal study group has definitely made me feel more able to support my math teachers. I feel confident to walk into the classroom and see the teaching of algebra and the learning of algebra going on."

Perhaps more importantly, however, the study group experience presented participants with a new vision for algebra teaching that encouraged group problem-solving and class discussion around carefully selected mathematical problems or tasks. As a result, participants came to new understandings about the importance of selecting high cognitive-demand tasks, giving students ample time to solve those problems together, and using good questions to facilitate classroom talk about the mathematical ideas embedded in those tasks. When observing instruction, these principals now wanted to see teachers and students engaged in sustained discussion around high-level mathematical tasks. As many of them reported, they were no longer content seeing teachers walk students through a set of procedural steps. Rather, they were now more interested in seeing students' collective inquiry into important mathematical ideas.

## CONFIDENCE TALKING WITH TEACHERS ABOUT MATHEMATICS

By drilling down into algebra content, principals became more aware of how disciplinary knowledge is structured in mathematics and the implications of that for teaching. Over time, participants were equally able to construct an understanding of algebra as the study of functions and patterns. In the words of one participant, "I learned the math behind the math." When asked how their leadership practice was changing as a result, principals told stories of spending more time observing in classrooms and then debriefing with teachers. They further described these conversations as lasting longer and addressing content in greater depth than previously. Notably, those without strong mathematics backgrounds were quick to credit these changes to increased confidence in their mathematics knowledge and in their growing ability to engage in mathematical reasoning.

## RENEWED COMMITMENT TO STUDENTS WHO STRUGGLE

By solving problems in small groups, then sharing their work with others, principals experienced firsthand the value of learn-

ing from others' approaches to problem solving. This understanding helped principals see how all students can participate in mathematical reasoning when given appropriate support. This realization was perhaps most compelling to those in the group without a strong mathematics background, but a strong affinity toward students who struggled in mathematics classrooms. The study group process of engaging together in high-level algebraic problem solving demonstrated that well-designed tasks provide all students — especially those who struggle — an opportunity to engage with the content in a meaningful way. As the following quote highlights, this awareness can also help principals communicate to teachers the importance of maintaining high expectations for all students.

“I am NOT a math person. I never have been. The way I learned math (sit-and-get) contributed to my anxiety about math. Through the principal study group, I have been exposed to a different style/technique for math instruction, and I'm actually learning math. It's a message I can share with my staff since many kids feel the same way about math that I did.”

#### LEADERSHIP FOR ALGEBRA REFORM

Looking back, the study group clearly helped participants develop a deeper appreciation for algebra content and adopt a set of concrete ideas around what it means to help students learn algebra. The study group also helped principals think differently about their leadership practices with respect to algebra teaching. As we talked with principals across the series, we stressed that school-level leadership is too often limited to evaluative activities such as summative observations and formative walk-throughs. Through the study group, we wanted to expand principals' conception of instructional leadership to include teacher support and development.

The data suggests, albeit subtly, that the development of leadership content knowledge (i.e. knowledge of the subject, knowledge of teaching, and learning the subject) among participants coincided with their ability to envision leadership practices that extended beyond supervision to include teacher support and development. Moreover, because study group sessions reinforced teaching practices most often associated with planning and leading instruction, the discussion of related leadership “moves” was often limited to those specific aspects of the classroom. Viewed together, this framing of the problem resulted in a wider range of leadership moves (e.g. support, develop, and assess) for a narrower range of teaching practices (e.g. lesson planning and delivery). Ultimately, this framing seemed to help principals gain traction on leadership practices that would be supportive of teachers as they adopted and implemented instructional strategies appropriate for all students.

From a practical standpoint, this framing further enabled us to pose questions that drilled down into content-specific leadership practice. For example, we could now ask: What can you do to support, develop, and/or assess teacher skill at selecting

high-level mathematical tasks for group problem solving? As a group or individually, we could then brainstorm appropriate responses, such as encourage a vision for algebra that puts an emphasis on mathematical reasoning; reassure teachers that time spent on high-level tasks will be rewarded; help teachers secure needed curricular and instructional resources; and pay attention to the cognitive demand of selected tasks when observing the classroom. This kind of discussion happened frequently and often informally in the study group. See more examples on p. 31.

#### CONNECTING LEADERSHIP TO TEACHING AND LEARNING

The intended goal of these sessions was to enhance principals' mathematical knowledge for algebra teaching by actively engaging participants in a representative slice of mathematics content. Through a series of sustained, content-rich study group sessions, participants gained new insights for observing algebra instruction and acquired a working knowledge-base that facilitated mathematical conversations with staff. Participants were also reminded of its importance: All students are deserving of the opportunity to master algebra content. Alone, these are powerful outcomes. In sum, however, they have the potential to reframe the practice of instruction leadership. As Stein and Nelson (2003) remind us:

Without knowledge that connects subject matter, learning, and teaching to acts of leadership, leadership floats disconnected from the very processes it is designed to govern (p. 446).

#### REFERENCES

- Smith, M.S., Silver, E.A., & Stein, M.K. (2005).** *Improving instruction in algebra: Using cases to transform mathematics teaching and learning* (Vol. 2). New York: Teachers College Press.
- Stein, M.K. & Nelson, B.S. (2003, December 21).** Leadership content knowledge. *Educational Evaluation and Policy Analysis*, 25(4), 423-448.
- Stein, M.K., Smith, M.S., Heningsen, M.A., & Silver, E.A. (2009).** *Implementing standards-based mathematics instruction: A casebook for professional development* (2nd ed.). New York: Teachers College Press.

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**Cynthia L. Carver (carver2@oakland.edu) is assistant professor of educational leadership at Oakland University. Michael Steele and Beth Herbel-Eisenmann are assistant professors of mathematics education at Michigan State University. ■**

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