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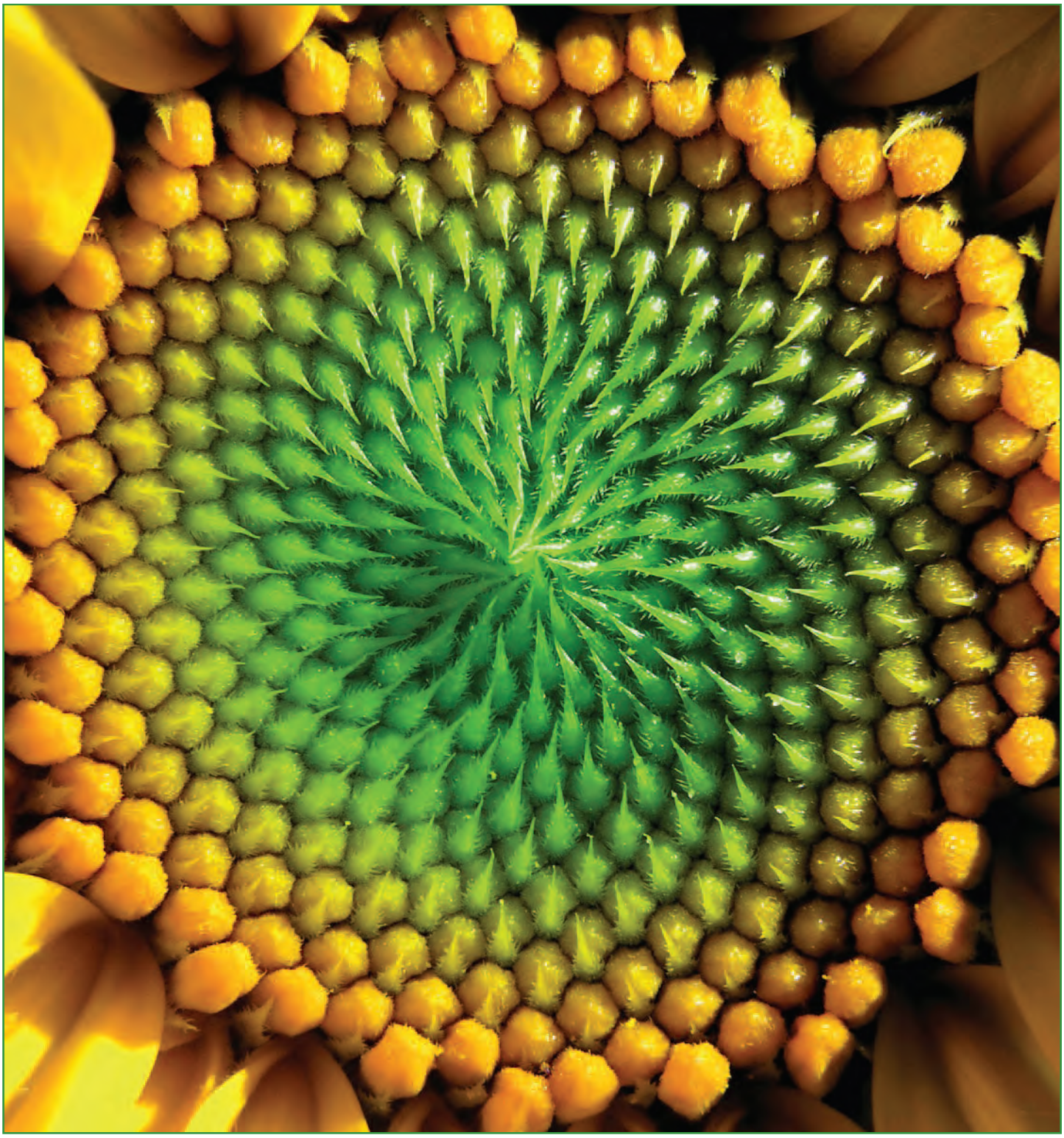

National Council of Supervisors of Mathematics *www.mathedleadership.org*

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Supporting Teachers' Effective Use of Curricular Materials

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Many of us working in mathematics education leadership roles have experienced the importance of and challenges in effectively supporting teachers as they learn to implement new curricular materials or materials new to them. Teachers need to be able to discern the important daily mathematical concepts embedded in the context of the unit, how these unfold over the school year, and how these relate to grade level expectations in terms of district or state standards (Roth McDuffie, Wohlhuter, & Breyfogle, 2011). In addition, teachers need to be able to consider students' prior knowledge and implication for how they might need to adapt, supplement, or omit portions of the materials to meet students' needs. For new teachers or teachers using new materials, this can truly be a daunting task. In this article, we draw from our professional development work in many classrooms (see Breyfogle & Spotts, 2011; Latterell & Wohlhuter, 2004; Roth McDuffie & Eve, 2009) to focus on how mathematics education teacher leaders, working directly with teachers in schools, can support teachers in this process. We view teachers leaders as persons who provide mathematics leadership within a building or a district and could have roles and titles such as mathematics specialists, mathematics coaches, principals, directors of curriculum and instruction, university mathematics educators, professional development leader, or other individuals who work to support mathematics teaching and learning in a school or district. We begin with a brief background and description of curricular reasoning—a type of reasoning that we have found is helpful for teachers to develop—and then discuss two settings in which teacher leaders can actively support teachers' development of this reasoning.

Importance of Curricular Reasoning

Two important shifts having to do with the effective use of curricular materials have occurred over the past two decades: (a) the publication of curricular materials aimed at problem solving, reasoning, and students' conceptual understanding of mathematics and (b) the development of curricular standards with increased accountability for learning measured by performance on state assessments. In response to these shifts, mathematics education leaders have realized the importance of helping teachers develop thinking processes to engage in as they work with curricular materials to plan, implement, and reflect on instruction, a process we refer to as *curricular reasoning* (Breyfogle, Roth Mc Duffie, & Wohlhuter, 2010; Roth McDuffie & Mather, 2009). Although curricular materials can strongly influence the nature of, and approaches to, mathematics teaching and learning, curricular materials alone do not ensure an effective lesson (Boaler, 2002). Teachers' decisions significantly influence this process. Below we focus on how teacher leaders can support the development of teachers' curricular reasoning while engaging in an observation-conferencing cycle and supporting teacher collaboration.

Observation-Conference Process Focusing on Use of Curricular Materials

The observation-conference process provides opportunities for dialogue between the teacher and teacher leader. In our work with different groups of teachers, this process was used to understand the classroom context and to determine the level of implementation of research-based effective teaching practices. In both situations, the observation-conference process was repeated on a regular basis (e.g., monthly) and typically occurred within the school day

during the teachers' planning period, usually on the day of or following the observed class sessions. Some teachers agreed to participate in the projects, some of which included the videotaping of lessons, but most were encouraged by their building administrators and consented to participate as a result.

In the research that focused on understanding the classroom context, the observation-conference process occurred between individuals that already knew each other. For the cadre of teachers focused on research-based effective teaching practices, we held professional development sessions afterschool or on established professional development days for in order to establish a rapport with teachers. Additionally, in some of our work, on-going professional development sessions occurred throughout the year of working with the teachers. For example, in one project, one of the authors was asked by the building principal to serve as a mentor to his four mathematics teachers who were struggling with the implementation of NSF-funded middle school materials during a two-year period. She first established a rapport with the teachers prior to these interactions by providing a two-day professional development session focusing on research-based effective teaching practices during pre-established professional development days. She then conducted the observation-conference sessions during the school day and provided two-hour after-school monthly professional development sessions focused on an issue of teaching that emerged from one of the conference-observations.

As teacher leaders, we can support teachers' curricular reasoning by encouraging teachers to focus on students' needs during discussions about the planning of lessons and to engage in focused reflection in the post-observation conference. While enacting this dialogue involving curricular reasoning, teacher leaders can demonstrate respect for teacher knowledge by employing deep listening and suspending their personal assumptions about the classroom (Glover, 2007). In this section we elaborate on ways in which these practices support curricular reasoning and improved instruction.

Making decisions based on students' needs. Effective teaching is characterized by teachers understanding students' mathematical knowledge, what mathematics students need to learn, and how best to help learning occur (NCTM, 2000). Teachers develop these practices by applying curricular reasoning to: identify and understand the mathematics, anticipate potential approaches that learners might bring to a lesson, and consider students' backgrounds and experiences (Breyfogle, Roth McDuffie, & Wohlhuter, 2010). Teacher leaders can assist in this process by explicitly discussing the above practices and posing appropriate questions during the planning of lessons.

Our work with teachers includes research that focused on understanding the teaching and learning process in beginning mathematics teachers' classroom (Latterell & Wohlhuter, 2004). How teachers provided learning opportunities was one component of a two-year study. An eighth-grade teacher with the long-term goal of students understanding properties of linear relationships in tables, graphs, and equations knew it was important for students to develop foundational ideas about rate of change. *The Connected Mathematics* (Lappan, Fey, Fitzgerald, Friel, & Phillips, 1998) curricular materials used walking rates as one context for exploring rate of change. The teacher supplemented the curriculum by having students observe classmates' walking rates before they engaged in the textbook's task that asked students to determine how different walking rates (e.g., 1.5 m/s, 2m/s, 2.5m/s) affected the distance traveled and time needed for traveling. She observed students working in groups and listened to them as they shared their solutions. Based on her observations the teacher considered the extent to which students were ready for the next lesson that focused on making tables and graphs.

Effective teacher leaders facilitate this kind of lesson planning by raising questions that help teachers identify and understand important aspects of curricular reasoning, including what mathematical ideas are embedded in the lesson and how students' backgrounds and experiences may affect learning. Possible questions for the rate of change lesson include:

- How do these mathematical ideas fit together?
- What is the trajectory of learning for rate of change embedded in or underlying the design of the curricular materials?
- What evidence do you have about students' current understanding that helped you determine to focus on rate of change in this way?
- How did your students learn about the concept of rate of change in previous years and where is it leading in your curriculum?

- From your experience, what have students struggled with about this idea and how has your planned lesson addressed this?
- What specific gaps or misunderstandings about rate of change might be uncovered during the lesson?
- How will you know what each student understood about the concept rate of change at the lesson's conclusion?
- How will you use what you learned about students' knowledge to determine the content of the next lesson?

Raising questions like these models the types of questions teachers should be regularly asking themselves.

Providing opportunities for focused reflection that supports curricular reasoning. Post-observation lesson discussions provide an opportunity for facilitating teachers' curricular reasoning development by focusing reflection on teaching and learning. This means that teacher leaders serve as sounding boards and mirrors, allowing teachers to reflect on their lessons and consider ways they might both revise how they would teach this lesson again in the future and also adjust the next lesson to meet students' needs. We have found this type of reflection to be instrumental in their curricular reasoning development.

In the project in which one of the authors served as a mentor to the four middle school teachers, each teacher set individual pedagogical goals for improving their teaching at the start of each year. The teachers chose goals such as finding ways to differentiate instruction to challenge all of her students and selecting tasks to increase students' level of engagement. During observations, the mentor kept these in mind and focused her note-taking on this particular aspect of the lesson, including identifying specific times on the video that could be revisited and discussed with the teacher during the interview following the observations. These goals and the teachers' level of success with the goals were individually evaluated at each of the subsequent monthly observation conferences.

The teacher leader observed a 6th grade teacher who set the personal goal of challenging her students while she taught a lesson with this objective: to determine if triangles could be made given any set of side lengths while classifying triangles according to the lengths of their sides (e.g., scalene, acute, equilateral or not possible). The plan for the lesson was for students to intuitively develop the Triangle Inequality Theorem by trying to construct eight different triangles given sets of side lengths. For this activity students were provided pipe cleaners of varying lengths and a lab-sheet (See Figure 1 on next page) to record their findings. Concerned about the accessibility of this task with all of her students, the teacher asked the students to draw and label an additional column on the table that said, "sum of two shorter sides" and told the students that they were going to see a rule. While walking around observing the small groups, she provided explicit suggestions like "focus on the 'length of largest' to 'sum' columns" that funneled the students' thinking rather than allowing them to generate their own conjectures. An unintended consequence of these kinds of prompts was that the teacher took away the problematic aspects of the task such that the students were completing steps rather than engaging in mathematical reasoning. Sensitized to the goal of challenging all of the students, the teacher leader made notes of these instances so that during the observation interview she could raise questions with the teacher. Showing the videotaped excerpts and asking questions like, "Why did you choose to provide this suggestion to this group?" or even more focused prompts such as "How did your hints/prompts affect students' engagement in mathematical thinking and reasoning of this task?" were intended to help the teacher identify moves that contributed to decreasing the cognitive demand of the task, as well as identifying more productive moves in teaching. Questions such as these help the teacher realize how seemingly minor changes to the curricular materials (e.g., adding the column to the lab sheet) and prompting the students with hints have the adverse effect of reducing or eliminating opportunities for students to engage in the reasoning processes on which the lesson objectives were aimed (for further elaboration see Roth McDuffie, Wohlhuter & Breyfogle, 2011).

To promote and support teachers' engagement in curricular reasoning while reflecting on lessons, teacher leaders can raise other questions such as:

- Did the sequence of tasks build understandings appropriately?
- Did you anticipate students' needs in preparing them to engage in the tasks?
- During the lesson's summary portion, did you sequence and connect ideas in the materials to solidify learning and to prepare for future lessons?

FIGURE 1: *Labsheet for Exploration*

Name_____Date_____

MODULE 1 **LABSHEET 2C**

Sides of a Triangle (Use with Questions 15 and 16 on page 17.

Directions Try to form a triangle with each stick combination. For each triangle you form,

- make a sketch and classify it as *scalene, isosceles*, or *equilateral.*
- record the lengths of its sides in the appropriate columns.

If you were not able to form a triangle, write *not possible*.

Stick combination	Sketch of triangle	Type of triangle	Length of the longest side	Length of the two other sides
3 in. 4 in. 5 in.		scalene	5 in.	3 in., 4 in.
2 in. 2 in. 5 in.				
3 in. 5 in. 5 in.				
6 in. 6 in. 6 in.				
2 in. 3 in. 4 in.				
2 in. 3 in. 6 in.				
3 in. 5 in. 8 in.				
5 in. 5 in. 8 in.				
4 in. 4 in. 8 in.				

(Billstein & Williamson, 1999)

Raising questions like these provides opportunities for focused reflection that supports curricular reasoning and models the types of questions teachers should be regularly asking themselves.

Supporting Collaborative Work Involving Curricular Reasoning

Teacher leaders need to establish and support teacher communities (Lattimer, 2007). Studies of collaborative teaching environments indicate that when teachers focus on students' learning, teaching practices and students' learning improves (e.g., McLauglin & Talbert, 2006). While various models for collaboration exist (e.g., professional learning communities, lesson study, video clubs), some common characteristics for effective collaborations emerged in our work with teachers' curricular reasoning.

Typically in our research, teachers collaborated in grade level teams, and in some cases the entire school staff participated (Roth McDuffie, 2009; Roth McDuffie & Eve, 2009). The team's work included: examining students' test data on state-wide or district assessments; designing and analyzing common classroom assessments; studying state curriculum documents for grade-level learning targets; analyzing curricular material's purpose, methods, scope and sequence across grades, and alignment with standards; and co-planning lessons, observing each others' teaching, and analyzing and reflecting on students' work. Teachers continually reflected that these collaborative activities affected their practice because activities were based in and relevant to their practice and students. In addition, these activities kept teachers focused on understanding and learning about students' thinking, teaching approaches, mathematics content knowledge, gaps and learning outcomes rather than limiting work only to "swapping new strategies and activities" that did not lead to real change. How teacher leaders structured and supported this collaborative work influenced the extent to which schools improved.

In a different two-year project, we collaborated with two elementary schools, with all teachers working in grade level teams as described above. In the second year, a new principal came to one of the schools. Although this principal supported and encouraged teachers' collaborative work, given that she was new to the school, she was reluctant to establish clear expectations or hold teachers accountable for collaborating with their teams to improve teaching and learning. This new principal's stance stood in contrast both to the other school and to the school's previous principal. Patterns for the relationship between a teacher leader's stance or actions and teachers' engagement in collaborative teams were evident. With these experiences and other researchers' findings in mind, we found that teacher leaders needed to both *support* and *expect* teachers' collaboration. Additionally, teachers needed to be held accountable for outcomes from their efforts. This accountability helped the whole school to prioritize collaborative school improvement. Below we discuss ideas for ways to support and expect collaborative work as teachers interact with their curricular materials and engage in curricular reasoning.

- Recognize that building this culture centered on improving students' learning requires time in the day and occurs over time in the year(s). Provide time and space (e.g., prioritize collaborative work in scheduling) for work to take place, and then ask for agenda and reports for team's activities and progress to maintain accountability.
- Help teams to develop goals for work centered on students' learning (different from collegial interactions which degenerate into "trading worksheets"). Depending on the model for collaboration, many resources are available to guide this process (e.g., Lewis, 2002; McLaughlin & Talbert, 2006).
- Ensure that teachers feel safe to try different approaches. Support responsible risk-taking by allowing them to keep collaborative planning, common assessments, and lesson observations separate from teachers' evaluations, and understand that innovations will need revisions and improvements. Expect teachers to justify their experimental approaches with research-based literature.
- Invest in the teams' efforts by attending meetings and serving as an active member. Teacher leaders' attendance provides opportunities to model deep listening and discourse that builds on participants' ideas. In addition, by listening to discussions, teacher leaders can identify ways to support teachers' work and address any early obstructive behaviors before they become a problem (e.g., a leader can hold a private discussion with a teacher who may be showing signs of obstructing the work to reflect back behaviors and explore how the teacher could better support the learning team).
- Allow teachers to drive and own the process, respect their knowledge and expertise (Lattimer, 2007), and value different ways each teacher can contribute.

Table 1. Roles for Participants in Collaborative Learning Settings

PARTICIPANT ROLE	DESCRIPTION OF CONTRIBUTIONS FROM PARTICIPANT IN THIS ROLE
Seasoned Practitioner	Anticipates trouble spots and strengths based on years of working with students.
Researcher	Reads professional literature, reviews and uses supplemental curricular materials, considers perspectives from educational research and theory, and/or attends outside workshops/speakers, and regularly shares new knowledge.
Organizer	Coordinates meeting scheduling, initiates agenda planning, keeps meeting notes and records, makes sure materials are prepared in advance, and reminds participants of responsibilities for follow through.
Encourager	Provides supportive comments, makes sure all voices and ideas are heard and valued, attends to emotional needs of participants, and keeps work moving in a positive direction.
Experimenter	Offers to try new approaches in his/her room as a test case, open to new strategies and/or using new materials, willing to pioneer new ideas (especially when others are reluctant to change and need to see it tested first).
Obstructer	Finds obstacles or reasons not to collaborate and improve. Participants should not permit others to take on this role, and teacher leaders may need to intervene to ensure that all participants are expected to avoid this role.

In considering the last recommendation, we identified a range of roles that teachers can take on in a collaborative environment. Participants' roles and the corresponding contributions that we have encountered are described in Table 1. These roles highlight a need for teacher leaders to value teachers' expertise, strengths, and voice in designing, planning, and implementing the collaborative learning, and if needed, to help teachers identify their roles. Teacher leaders and participants must expect and communicate that the *obstructer* is not an acceptable role. Note: critically examining and carefully considering new approaches/materials (a form of curricular reasoning) is an important part of the process to ensure that new approaches are not tried just because they are different, and this type of thinking should not be confused with obstructing the work.

Conclusion

In this article, we have conceived of "teacher leaders" quite broadly to include persons with various roles in a building and/or district and who are in a position to support teachers in their professional development and learning. A theme underlying the recommendations and approaches we discussed is that teacher leaders need to actively look for and provide opportunities to engage teachers in examining their practices and supporting their students' needs and learning. Specifically, we focused on developing curricular reasoning as an important part of becoming an effective mathematics teacher. Teacher leaders can help develop teachers' curricular reasoning by considering powerful questions to ask during teachers' design and lesson planning and when observing teachers, and also by encouraging and supporting their collaborative work.

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