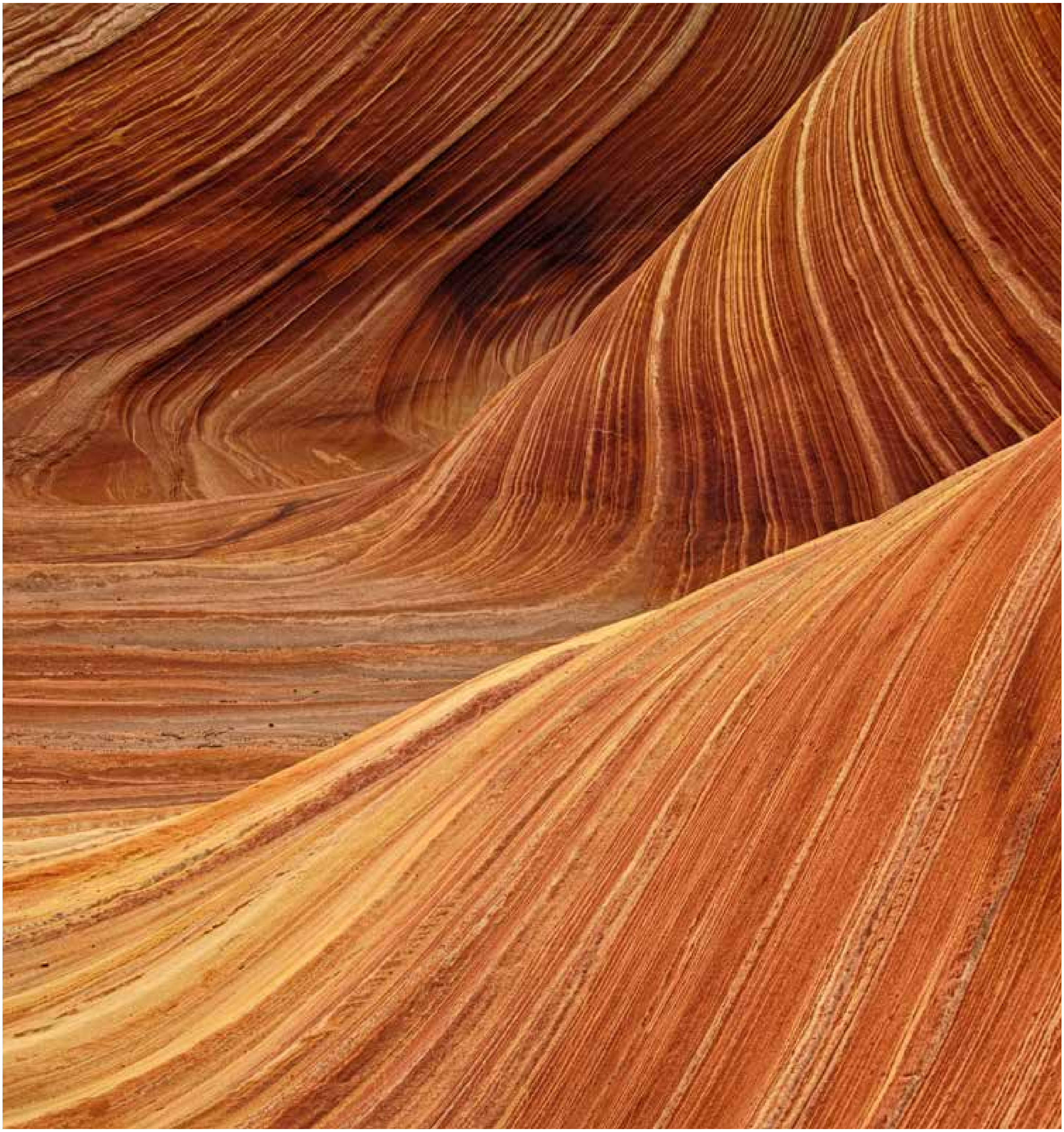
NCSM Journal

of Mathematics Education Leadership

FALL 2017 VOL. 18, NO. 2



National Council of Supervisors of Mathematics www.mathedleadership.org

Call for Manuscripts

The editors of the ***NCSM Journal of Mathematics Education Leadership*** are interested in manuscripts addressing issues of leadership in mathematics education and reflecting a broad spectrum of formal and informal leadership at all levels. Categories for submittal include:

- **Key topics** in leadership and leadership development
- **Case studies** of mathematics education leadership work in schools and districts or at the state level and the lessons learned from this work
- **Reflections** on what it means to be a mathematics education leader and what it means to strengthen one's leadership practice
- **Research reports** with implications for mathematics education leaders
- **Professional development efforts** including how these efforts are situated in the larger context of professional development and implications for leadership practice
- **Commentaries on critical issues** in mathematics education
- **Brief reviews of books** that would be of interest to mathematics education leaders

Other categories that support the mission of the journal will also be considered. Currently, the editors are particularly interested in manuscripts that address the leadership work of mathematics coaches and mathematics specialists.

We also invite readers to submit letters to the editor regarding any of the articles published in the journal. We seek your reactions, questions, and connections to your work. Selected letters will be published in the journal with your permission.

Submission/Review Procedures

Submittal of manuscripts should be done electronically to the ***Journal*** editor, currently Angela Barlow, at ncsmJMEL@mathedleadership.org. Submission should include (1) one Word file with the body of the manuscript without any author identification and (2) a second Word file with author information as you would like it to appear in the journal. Each manuscript will be reviewed by two volunteer reviewers and a member of the editorial panel.*

***Note:** Information for manuscript reviewers can be found at the back of this publication.

NATIONAL COUNCIL OF SUPERVISORS OF MATHEMATICS (NCSM)

Inquiries about the ***NCSM Journal of Mathematics Education Leadership*** may be sent to:
Angela T. Barlow
201 Donaghey Ave., Torreyson West, Room 328
Conway, AR 72035
Email: ncsmJMEL@mathedleadership.org

Other NCSM inquiries may be addressed to:
National Council of Supervisors of Mathematics
PO Box 3406
Englewood, CO 80155
Email: office@ncsmonline.org • ncsm@mathforum.org

Table of Contents

Purpose Statement

The ***NCSM Journal of Mathematics Education Leadership*** is published at least twice yearly, in the spring and fall. Its purpose is to advance the mission and vision of the National Council of Supervisors of Mathematics by:

- Strengthening mathematics education leadership through the dissemination of knowledge related to research, issues, trends, programs, policy, and practice in mathematics education

- Fostering inquiry into key challenges of mathematics education leadership

- Raising awareness about key challenges of mathematics education leadership, in order to influence research, programs, policy, and practice

- Engaging the attention and support of other education stakeholders, and business and government, in order to broaden as well as strengthen mathematics education leadership.

Comments from the Editors

Angela T. Barlow, *University of Central Arkansas*
Carolyn Briles, *Loudoun County Public Schools/Riverside High School*

To support the professional growth of teachers, reflection continues to be highlighted as a primary component of effective professional development (Saylor & Johnson, 2014). In this issue, reflection appears as a common thread of the three articles. Across the articles, however, reflection looks quite different in terms of when the reflection occurs and by whom.

One way to characterize reflection involves what Schön (1983) termed reflection-in-action. When engaged in reflection-in-action, the teacher's reflective ideas can be used to influence the current situation. In their article "Teacher Time Out: Educators Learning Together In and Through Practice," Gibbons, Kazemi, Hintz, and Hartmann describe an organizational routine, referred to as *Teacher Time Out* (TTO), that provides this opportunity for reflection-in-action. In their work, teachers collaboratively plan and execute a lesson, during which they have the opportunity to pause the lesson, or call a time out, to question colleagues about the lesson's direction. In the article, Gibbons and colleagues not only describe the routine but also share dialogue taken from an example lesson that involved several TTOs. In addition, they share the results of an exploratory analysis of these TTOs.

In contrast, Franz, Wilburne, Polly, and Wagstaff describe an activity that engages teachers in what Schön (1983) described as reflection-on-action. In this case, reflection occurs after an event has occurred and is the basis for thinking about future events. In their article "The Teacher Action Q-sort: A Card-Sorting Tool for Professional Learning," Franz and colleagues describe a card-sorting tool, known as a Q-sort, that supports teachers in reflecting on their instructional practices. In the Q-sort, teachers sorted statements related to the Mathematics Teaching Practices (National Council of Teachers of Mathematics, 2014), reflecting on which statements were most/least characteristic of their teaching. The authors share the procedures for having teachers complete the Q-sort. In addition, they offer the results of their analysis focused on teachers' responses to and perceptions of the Q-sort activity.

Finally, in the article "Elementary Mathematics Specialist Program: One State's Story of Development and Implementation," Reeder and Utley continue the theme of reflection-on-action as they share their experience as mathematics educators engaged in the development and implementation of an elementary mathematics specialist program in their state. Their story is one of hope and frustration, as they describe the process that led to their current context for certification of elementary mathematics specialists. By reflecting on their process, its successes, and its challenges, the authors intend to support others who are potentially engaging in similar efforts as well as draw upon others' support in addressing remaining challenges.

As you read this issue, we hope that you recognize the role of reflection within each article. We also hope that you will reflect upon your own practices in working with mathematics teachers and consider sharing those practices with the journal's readers. ✪

References

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all.* Reston, VA: Author.

Schön, D. (1983). *The reflective practitioner: How professionals think in action.* London: Temple Smith.

Saylor, L. L., & Johnson, C. C. (2014). The role of reflection in elementary mathematics and science teachers' training and development: A meta-synthesis. *School Science and Mathematics, 114*, 30–39.

The Teacher Action Q-Sort: A Card-Sorting Tool for Professional Learning

Dana P. Franz, *Mississippi State University*
Jane Wilburne, *Penn State – Harrisburg*
Drew Polly, *University of North Carolina at Charlotte*
David A. Wagstaff, *Penn State – University Park*

Abstract

Reflection is an essential component of classroom teaching that successful mathematics teachers perform routinely and it is one of the imperatives that the National Council of Supervisors of Mathematics has identified as being integral to the provision of effective instruction that maximizes learning for all students. Reflecting on one's mathematics teaching promotes self-awareness and facilitates the implementation of the desired teaching practices. In this article, we report on the use of a Q-sort to promote teachers' reflection on their teaching as the latter relates specifically to their enactment of teacher actions associated with high-quality teaching practices. We share teachers' reflections on their use of the Teacher Action Q-sort and their views regarding the benefits of using a Q-sort. We also address mathematics coaches' insights on how a Q-sort can be used as a needs assessment and as a professional learning experience for teachers who want to conduct a self-appraisal of the degree to which they implement high-quality classroom teaching practices that provide all students with meaningful mathematics instruction.

Introduction

Mathematics teachers need to have opportunities to reflect on their classroom teaching practices, particularly their use of specific instructional practices (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010). The true mark of effective teachers is their ability to reflect on their teaching and seek opportunities to share what they have learned with other teachers (National Council of Supervisors of Mathematics [NCSM], 2014). Schön (1983, 1987) referred to reflection on specific actions or teaching practices after their occurrence as reflection-on-action. A critical component of professional development programs should include opportunities for teachers to reflect on their classroom teaching practices and share their experiences with other teachers (Garet et al., 2010; NCSM, 2014). Teachers gain confidence in knowing the areas in which they need to enhance their teaching practices, and they need to think critically about how to "strengthen the quality and effectiveness of their work" (Cimer, Cimer, & Vekli, 2013, p. 134). By becoming aware of their teaching and by thinking critically about their teaching practices, teachers can shape their teaching to better meet students' needs (Bengtsson, 1995; Ferraro, 2000). To this end, activities that provide opportunities for reflection on classroom teaching practices can serve as an important component of a program designed to facilitate teacher learning (Loucks-Horsley et al., 2010). Teacher leaders and coaches can develop teachers' mathematical teaching practices by providing experiences that encourage teachers to engage in purposeful reflection on the practices they use in the classroom (Munter, Stein, & Smith, 2015).

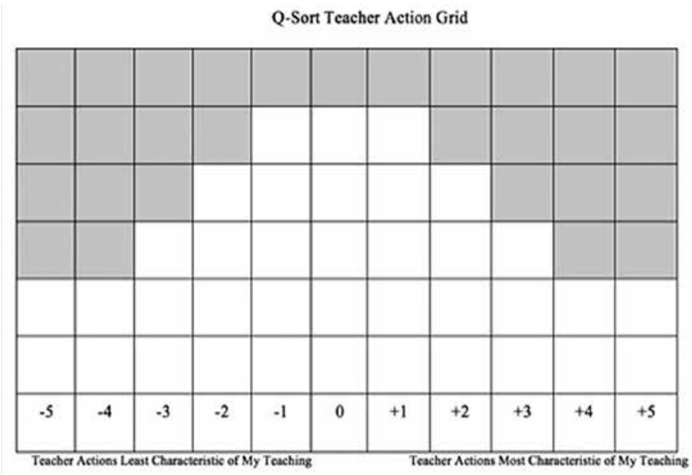
Providing meaningful opportunities for teachers to reflect on their practices is essential for teacher learning. With this goal in mind, we describe a card-sorting tool known as a Q-sort and how it was used in a research study that was conducted in Spring 2016 to promote grades 4-10 mathematics teachers' reflection on their instructional practices (Wilburne, Polly, Franz, & Wagstaff, 2017). We will summarize key points elicited from the teachers' written reflections and their reaction to the use of the Q-sort. We will also share mathematics coaches' insights regarding ways they see that the Q-sort can be used by individuals who want to conduct a needs assessment. Although we used the Q-sort as part of a research study, we will describe how it can be used by mathematics leaders in a professional development setting as well as the advantages and disadvantages of a Q-sort.

The Q-Sort Process

Q-sorts are commonly associated with a research approach known as Q-methodology (Brown, 1980). Q-methodology involves engaging participants in an active examination of their perspectives, opinions, feelings, or beliefs on a topic. Like many qualitative methods, Q-methodology does not require a large number of participants since the results are not intended to be representative of a population (McKeown & Thomas, 2013). A Q-sort, the Q-methodologist's primary data-collection tool, was developed to provide study participants and Q-methodologists with a systematic means to have participants reflect upon whatever stimuli, typically statements, are presented to the participants on cards. Q-methodologists refer to the statements as the Q-set. The Q-set, when properly constructed, represents the *concourse* or the relevant viewpoints on a topic. In our study, the concourse was 37 statements of the teaching actions that support the eight Mathematics Teaching Practices identified in the *Principles to Actions: Ensuring Mathematical Success for All* (National Council of Teachers of Mathematics [NCTM], 2014). Both NCSM (2014) and NCTM (2014) have identified high-quality teaching actions that represent the teaching needed to equitably support each student. We focused on the eight NCTM (2014) mathematics teaching practices because of the extended descriptions NCTM provided for each practice. These practices are: 1) establishing mathematics goals, 2) posing tasks that promote reasoning, 3) using mathematical representations, 4) facilitating mathematical discourse, 5) posing purposeful questions, 6) building fluency from conceptual understanding, 7) supporting productive struggle, and 8) eliciting and using evidence of student thinking. The description of each practice includes research to support the practice, case studies and vignettes that demonstrate how each practice could be implemented in a classroom, and a table that identifies *Teacher and Student Actions* that promote implementation of the practice. In total, the eight tables identify 37 teacher actions that teachers can enact in their classrooms in order to implement the eight high-quality teaching practices. Appendix A lists the 37 teacher actions which are aligned with the NCTM Mathematics Teaching Practices (see NCTM (2014) for specific practices).

The product that results from participants' use of the Q-sort is a visual distribution of the statements that each participant has ranked from *most important* or *most characteristic* to *least important* or *least characteristic*. In our study, participants were instructed to place each of the 37 cards on a forced-choice Q-grid that consisted of 11 columns labeled from -5 (Least Characteristic of My Teaching) to +5 (Most Characteristic of My Teaching) (see Figure 1). Each column consists of a researcher-specific number of cells that are chosen in order to yield a symmetrical distribution. The decision to use a forced-choice Q-grid instead of a free distribution grid is frequently made for two reasons. First, data obtained by earlier research or a pilot study suggests that a symmetrical distribution appropriately reflects the concourse. Second, a forced-choice Q-grid prevents a participant from ranking all of the statements the same way (Brown, 1980). We used an 11-column grid that reflected a symmetrical distribution. The grid forced the participants to identify the same number of similarly ranked statements. A number was randomly assigned to each of the 37 teacher action cards so that the research team could identify how each participant had ranked the statement. The participants were asked to record the number that was on each card onto a sheet of paper that displayed a smaller grid shaped like the grid that they had used to rank the 37 cards. The data recorded on these small grids by participants gave the rankings of the 37 teacher actions by the 38 study participants. Appendix A also identifies the numbers that were associated with each statement.

FIGURE 1.
Q-sort forced-choice grid.
(Wilburne, Polly, Franz, & Wagstaff, 2017)



Methodology

Q-Sort as a Card-Sorting Tool

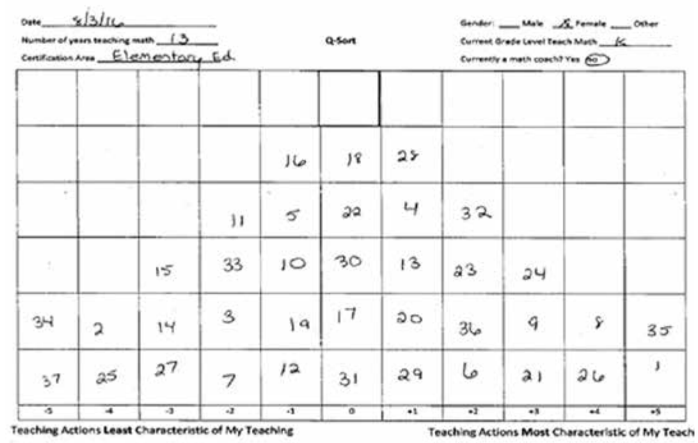
In Spring 2016, we enrolled 38 inservice mathematics teachers in a research study that required them to reflect on their classroom teaching actions and conduct a self-appraisal of the degree to which they enact high-quality instructional practices in their classrooms. The study sought to address three questions: Which teacher actions do the teachers identify as most characteristic of their teaching and why? Which teacher actions do the teachers identify as least characteristic of their teaching and why? What common perspectives do the participating teachers hold about their mathematics teaching actions?

The locations for the study were based on proximity to the authors' home institutions. The study participants were 13 mathematics teachers from Mississippi, 10 mathematics teachers from North Carolina, and 15 mathematics teachers from Pennsylvania. The 38 teachers taught grades 4 -10 in rural, urban, and suburban classrooms and had classroom teaching experience that ranged from 1 to 30 years (mean = 9.3; median = 7.5). To ensure data quality, common data collection protocols were implemented at each location. The study used the previously described data collection procedure known as a Q-sort.

Procedures

Once the participants arrived they sat at tables where they had room to work independently. Each teacher received a set of the 37 cards and a large copy of the Q-grid (19" x 10"). The 37 statements were printed on cardstock and cut to fit the 1.5" x 1.5" cells of the symmetrical Q-grid (see Appendix A). The participants read each statement and placed it in one of three piles: (a) actions most characteristic of their teaching, (b) actions least characteristic of their teaching, and (c) actions in between. Then they placed the statements from the three piles one-by-one on the cells of the large symmetrical Q-grid. This required the participants to reflect further about the extent to which they enact each of the teacher actions in their classroom teaching. After they finished placing all of the statements on the large Q-grid, the participants recorded the placement of each statement on a smaller 8.5" X 11" version of the Q-grid that they later used to discuss their grids in group discussion (see Figure 2). The Teacher Action Q-grid captured each teacher's rating of how they ranked the teaching actions that they enacted in heir classroom teaching.

FIGURE 2.
Sample of the smaller (8.5" x 11") Q-grid with a participant's statement numbers.



Upon completing the Q-sort, the facilitators directed the participants to reflect on their reasons for placing each card with its statement of a teacher action where it had been placed. Participants were to give special attention to the reasons why they had placed certain teacher actions at the extreme ends of the grid. The participants wrote their reflections on the bottom of the Q-grid. The facilitators led a group discussion after the completion of the activity asking questions such as: What teaching actions did you find easiest to place and why? What teaching actions did you find hardest to place and why? The facilitators also had the participants share their reactions to having completed the card sort of teacher actions. Comments were recorded and transcribed by the facilitators for the research study.

Results

Teachers' Reflections of their Teaching Actions

The facilitators asked the teachers to respond to the following questions: Which teacher actions did you place as most characteristic of your teaching and why? and Which teacher actions did you place as least characteristic of your teaching and why? We tallied the number of times that each statement was identified as most/least characteristic of the participants (Saldaña, 2013). Then, we used an Excel spreadsheet to list the qualitative statements and the associated teaching action.

The most characteristic teaching action among the participants was "*Praise students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems.*" Several participants wrote that they ranked this teacher action highest because it is something they do naturally and it motivates students. One female middle school teacher wrote, "I do not have to put much effort into praising students." Another female elementary school teacher wrote, "Actions like praising students are things I do naturally." However, one male, middle school teacher who ranked this statement as least characteristic of his teaching wrote, "I know I should praise students for their efforts but I also want them to work hard and motivate themselves."

The least characteristic teaching action among the participants was "*Identify what counts as evidence of student progress towards mathematics learning goals.*" Participants noted that this action should be ranked higher; however, they often struggle to identify evidence that students have met learning goals. As one female, high school teacher wrote, "I set goals at the beginning of the week but I don't look at them continuously through the week and I don't often look to see if my students are meeting the goals until I give a test." One male, middle school teacher wrote, "I want to gather evidence of student understanding but I find that I'm not consistent with it like I feel I should."

In our study we found the participating mathematics teachers held some common perspectives about their teaching practices. Many of the participants ranked teaching actions that required little planning or actions that took small amounts of classroom time such as "*Praise students for their effort in making sense of mathematical ideas*" and "*Allow sufficient wait time so that more students can formulate and offer responses*" as being most characteristic of their teaching. The participants shared that time constraints were the primary rationale for such rankings. Some of the participants' comments highlighted how activities such as engaging students in cognitively demanding tasks, facilitating classroom discussions, and posing higher-level questions require class time and were ranked least characteristic of their classroom teaching. For example, one male, elementary school teacher wrote, "Some of these I would love to do more, but I rarely have enough time in a given school day to be able to accomplish them to satisfaction." A female, high school teacher wrote, "We are so busy making sure we cover content that students lose out on many of these opportunities." In one case, a female elementary teacher wrote, "Actions like posing tasks on a regular basis I placed under least like me because I can't find the time to do them but I know I should. Also, I know my students are not ready to do these things."

The foregoing statements by our participants provide insight into how these teachers perceived their implementation of high-quality teaching practices. The Q-sort provided a visual tool that enabled participants to reflect upon the teacher actions they enact more often. Being aware of which teacher actions are most characteristic of their teaching and which teacher actions are least characteristic of their teaching can help teachers improve their classroom teaching (Cohen & Ball, 1999; Ferraro, 2000).

Teachers' Reactions to the Q-Sort Activity

The mathematics teachers who participated in the Q-sort enjoyed the activity and reported that the card sorting allowed them to purposefully reflect on their teaching practices. The activity helped the participants articulate their beliefs about what high-quality mathematics teaching may or may not look like in their classroom. The requirement to place some of the teacher action cards under *least characteristic of my teaching* ensured that each participant would think about their own classroom practices and identify the teaching actions they enact more than others. One participant commented, "It was a good reflection of my teaching practices. I like how it forced me to score some low." It was also the case that some participants found it was easy to place actions under *least characteristic of my teaching* because they believed that they do not enact these actions as often as they enact other teacher actions. As one participant noted, "The hardest actions to place are the ones that I do not feel I have enough time to adequately give justice to, even though they describe the teacher I am, or at least the teacher I ascribe to be." Several participants said it was easy to place teacher actions in the cells designated as least characteristic of my teaching. These participants reported that they did not enact these actions often because of time pressures or classroom management issues. The following are sample statements given by the mathematics participants after completing the Q-sorts.

> "The hardest actions to place were those that I know I don't do because they have a time component. Unfortunately, this time is not available in most classrooms."

> "I placed actions that facilitate discourse among students on the least characteristic end. Many times the student discussions go off onto topics not related to the class and induces classroom behavior issues."

Many participants were surprised when they compared their teacher action Q-sorts with other participants and found they had ranked different practices at the ends of the Q-grid. In one notable case, participants disagreed on the value of the teacher action *Select and sequence student approaches and solution strategies for whole-class analysis and discussion*. One of the participants stated that she did not have time to have students examine different strategies and she questioned the value of this action especially with the pressures to meet state-testing expectations. This opened a discussion with the other participants who had ranked the teacher action higher because they believed it is a practice that can promote student learning. This discussion also allowed the participants to express their differing viewpoints regarding why they see this action as helping all students become mathematically proficient. Although the goal was not to have participants compare their Q-sorts with one another, many of the participants found it interesting to do so and shared their rationales for placing their cards in particular cells.

The discussion on participants' placement of the cards also exposed beliefs some participants held regarding groups of students and how the participants may limit these students' access to high-quality instruction. Identifying these inequitable learning opportunities opens the door for discussions on how to eliminate these barriers and maximize the learning experience for every student. The following three quotes highlight these beliefs:

> "The cards that referred to tasks were easy to place under least like me because my students' don't have the prior knowledge to do them."

> "Higher-level thinking questions like [the actions on] #13, #17, #34, and #3 are difficult when students have problems with basic math skills."

> "Things that require students to persevere I rated low because most of the students are lazy and don't want to put in the effort to read and solve a problem."

The use of this sorting activity actively engaged participants throughout the Q-sorting session. The activity's value comes from having to think about and decide where to place the cards initially in the three piles, having to refine one's initial placement, making discriminatory judgments among somewhat similar actions, and then having to think about and provide reasons for one's rankings. For example, a female, middle-level participant placed the teacher action *Allow sufficient wait time so that more students can formulate and offer responses* [statement 8] under the -5 column (Least Characteristic of My Teaching). During the follow-up discussion she clarified the reason for her ranking of this action. "I believe in sufficient wait time but I struggle to balance wait time with getting through the material."

Finally, the sorting activity served as an experience that allowed participants to think about research-based instructional practices and reflect on which practices align most with their actual teaching practices. Reflection was supported through the critical analysis of participants' placement of the teacher actions on the Q-grid and follow-up discussions (Cimer et al., 2013). As three participants noted:

> "It was a good reflection of my teaching practices. I like how it forced me to score some teacher actions low."

> "It was tough. I learned what I value in my teaching, where I need to grow, and what I should focus on in the future."

> "It really made me stop and think about things I do in my classroom as well as improvements that needed to be made. I could see a pattern emerging as I placed my cards. I really found areas of my teaching I want to fix."

Mathematics Coaches' Reflections on the Use of Teacher Action Q-sorts

In the fall 2016 we recruited 25 elementary and secondary mathematics coaches and had them perform the same card-sorting activity that we had conducted with the mathematics teachers. The coaches were either participating in a professional learning workshop on coaching strategies in Pennsylvania (n = 15) or in Mississippi (n = 10). We asked the coaches to sort the 37 Teacher Action cards and place them on the Q-grid according to how they characterize their teaching practices. If they were not currently in a classroom, we asked them to sort the cards as best as they could recall of their most recent classroom teaching experience. After the coaches completed the Q-sort and recorded the number of the cards on the smaller Q-grid, we asked them to reflect on the activity and on the value of doing a similar activity with mathematics teachers with whom they work.

Overall, the coaches found the Q-sort to be a non-threatening activity that encouraged teachers to reflect on their teaching practices and discuss the strengths and weaknesses of their classroom teaching practices. One male coach commented, "I like this [Q-sort] because it is not evaluative, the teachers can honestly reflect on their own practice. There is no pressure." The coaches found that the Q-sort required teachers to make decisions about their teaching practices and really think about which practices they enact more often than other practices. They noted that the Q-sort served as a needs assessment tool that coaches could use to gather information on a classroom teacher's practices such as identifying the teaching actions a teacher ranked *least characteristic* of their classroom teaching. As one coach noted, "[Q-sort] forces them to look at their teaching and think about what teaching actions they do more often than others." Another coach added, "I really enjoyed the Q-sort activity. I love the possibilities for discussion that can come from it and the ability to do some targeted goal setting with my teachers."

Additionally, the coaches felt the Teacher Action Q-sort would be ideal for use in a professional learning community to promote discussions on topics such as how the different teaching practices are enacted in classrooms, how to ensure high-quality teaching practices occur in every K-12 mathematics classroom, and how to identify goals to pursue as a group or individually with a coach in order to improve classroom teaching. One coach noted, "The Q-sort allows me to see the variety of practices that the teachers are doing and talk about what practices the teachers want to get better at." The coaches agreed that the Teacher Action Q-sort should not be used to evaluate teachers or to compare a teacher's completed Teacher Action Q-sort with a coach's observation of the teacher's instruction. One group agreed, saying collectively, "We like the Q-sort because it is non-evaluative."

The coaches recognized that the Q-sort provided a quality framework for reflection. Only with authentic reflection experiences will teachers begin to understand the changes they must make to adjust instruction. One coach noted, "The Q-sort really makes teachers reflect on how they teach and what they can change to improve in their own classroom." Further, teachers can consider their understanding of high-quality instructional practices. "The Q-sort allows teachers to ask questions about the teaching practices, get clarification." Facilitating discussions on high-quality instructional practices allows teachers to engage with each other about enacting the practices. "I can see the benefit of having teachers do the Q-sort to reflect on their practices. There could be some good discussion on the themes the teachers see as evident in their Q-sort."

Using a Q-Sort in Professional Learning Sessions

The Teacher Action Q-sort provides teacher leaders with opportunities to identify similarities and differences among teachers' enactment of high-quality practices that seek to give every student access to meaningful math instruction. Q-sorts can be used with any number of teachers and can be completed in 20-30 minutes which is less time than it takes to observe a teacher present a classroom lesson. Table 1 provides an overview of the Q-sort process. Similar Q-sorts could be used with preservice teachers, principals, and other classroom teachers as a tool to promote discussion on high-quality classroom teaching practices and to articulate participants' beliefs regarding what high-quality mathematics teaching entails. When using a Q-sort as a reflection tool, statistical analysis is not needed. However, simple descriptive statistics like means and standard deviations could be used to determine the highest and lowest ranked statements if data were obtained from a group of teachers and that information would be valuable.

Table 1: Overview of the Teacher Action Q-sort Process

Step	Activity
1	Identify the concourse or set of statements on the topic (e.g., Appendix A).
2	Prepare the Q-sort grid and cards for the activity.
3	Select the participants and a space with tables to accommodate everyone.
4	Administer the Q-sort (approximately 20 - 30 min.) (e.g., Appendix B).
5	Conduct the reflection through individual interviews, small group discussions, or as a whole group.

Q-sorts of teaching practices require that participants report which of the desirable teaching practices are *Least Characteristic of My Teaching*. This requirement reduces the opportunity for participants to provide socially desirable responses which can happen when participants complete self-report questionnaires and surveys that have items measured on a Likert scale (Kazdin, 1998). Appendix C summarizes the advantages and disadvantages of using a Q-sort.

Although the Q-sort provides teacher leaders with information that can serve as a tool for reflection and collecting data for a needs assessment, we note several cautions. The results of a Q-sort are not intended to estimate a population. Consequently, the results are not generalizable to a hypothetical or finite population of teachers. Moreover, the Q-sort should not be used as an evaluative tool. Rather, it is a tool to elicit information and promote reflection on a teacher's implementation of high-quality teaching practices. When using the tool for a needs assessment, professional development providers and mathematics coaches should be sure to use probing questions to target the issues and constraints that teachers describe restrict their implementation of high-quality teaching actions.

Conclusion

The extent to which mathematics teachers enact teaching actions associated with high-quality practices vary from classroom to classroom. Teachers place different priorities on the use of certain practices depending on such things as grade level, composition of the classroom, and learning goals. The Teacher Action Q-sort provides teachers with insight into which high-quality practices they implement more than others. Teachers found the Q-sort to be an enjoyable, easy-to-complete activity that challenged them to think deeply about their teaching. Mathematics coaches found the Q-sort served as a tool to help teachers identify which teaching actions they struggle to implement and the professional development needs that may help them promote meaningful mathematics instruction for all students. Although the Q-sort can be used to collect data for a research study, it can also be used to promote conversations and reflections for professional development purposes. Mathematics education leaders can use the Q-sort with preservice teachers, inservice teachers, and school district administrators to enable them to become aware of their teacher action knowledge and beliefs. ✪

References

Bengtsson, J. (1995). What is reflection? On reflection in the teaching profession and teacher education. *Teachers and Teaching: Theory and Practice, 1*, 23-32.

Brown, S. R. (1980). *Political subjectivity: Applications of Q Methodology in political science.* New Haven, CT: Yale University Press.

Cimer, A., Cimer, S. O., & Vekli, G. S. (2013). How does reflection help teachers to become effective teachers? *International Journal of Educational Research, I,* 133-149.

Cohen, D. K., & Ball, D. L. (1999). *Instruction, capacity, and improvement.* (CPRE Research Report No. RR-043). Philadelphia, PA: University of Pennsylvania, Consortium for Policy Research in Education.

Ferraro, J. M. (2000). *Reflective practice and professional development.* ERIC Digest, No: 449120.

Garet, M. S., Wayne, A. J., Stancavage, F., Taylor, J., Walters, K., Song, M., . . . Doolittle, F. (2010). *Middle school mathematics professional development impact study: Findings after the first year of implementation* (NCEE 2010-4009). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Kazdin, A. (1998). *Research design in clinical psychology* (3rd ed.). Boston, MA: Allyn & Bacon.

Loucks-Horsley, S., Stiles, K. E., Mundry, S., Love, N., & Hewson, P. W. (2010). *Designing professional development for teachers of science and mathematics* (3rd ed.). Thousand Oaks, CA: Corwin Press.

McKeown, B., & Thomas, D. (2013). *Q methodology* (2nd ed.). Newbury Park, CA: Sage.

Munter, C., Stein, M. K., & Smith, M. S. (2015). Is there a common pedagogical core? Examining instructional practices of competing models of mathematics teaching. *Journal of Mathematics Education Leadership, 16*(2), 3-13.

National Council of Supervisors of Mathematics. (2014). *It's time: Themes and imperatives for mathematics education.* Bloomington, IN: Solution Tree Press.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for all students.* Reston, VA: Author.

Saldaña, J. (2013). *The coding manual of qualitative researchers* (2nd ed.). Los Angeles, London: Sage.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action.* London: Temple Smith.

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions.* London: Jossey-Bass Publishers.

Wilburne, J., Polly, D., Franz, D. & Wagstaff, D. (2017). *Mathematics teachers' perceptions of their teaching actions: A Q-methodology study.* Manuscript submitted for publication.

APPENDIX A

Cards for Q-Sort Reflection Activity

Establish clear goals that articulate the mathematics students are learning as a result of instruction in a lesson, over a series of lessons, or throughout a unit. [6]	Identify how the goals fit within a mathematics learning progression. [27]	Discuss and refer to the mathematical purpose and goal of a lesson during instruction to ensure that students understand how the current work contributes to their learning. [7]	Use the mathematics goals to guide lesson planning and reflection and to make in-the-moment decisions during instruction. [23]
Motivate students' learning of mathematics through opportunities for exploring and solving problems that build on and extend their current mathematical understanding. [28]	Select tasks that provide multiple entry points through the use of varied tools and representations. [32]	Pose tasks on a regular basis that require a high level of cognitive demand. [3]	Support students in exploring tasks without taking over student thinking. [11]
Encourage students to use varied approaches and strategies to make sense of and solve tasks. [26]	Select tasks that allow students to decide which representations to use in making sense of the problems. [24]	Allocate substantial instructional time for students to use, discuss, and make connections among representations. [33]	Introduce forms of representations that can be useful to students. [4]
Ask students to make math drawings or use other visual supports to explain and justify their reasoning. [9]	Focus students' attention on the structure or essential features of mathematical ideas that appear, regardless of the representation. [12]	Design ways to elicit and assess students' abilities to use representations meaningfully to solve problems. [13]	Engage students in purposeful sharing of mathematical ideas, reasoning, and approaches, using varied representations. [5]
Select and sequence student approaches and solution strategies for whole-class analysis and discussion. [37]	Facilitate discourse among students by positioning them as authors of ideas, who explain, and defend their approaches. [34]	Ensure progress toward mathematical goals by making explicit connections to student approaches and reasoning. [29]	Advance student understanding by asking questions that build on, but do not take over or funnel, student thinking. [19]
Make certain to ask questions that go beyond gathering information to probe thinking and require explanation and justification. [31]	Ask intentional questions that make the mathematics more visible and accessible for student examination and discussion. [17]	Allow sufficient wait time so that more students can formulate and offer responses. [8]	Provide students with opportunities to use their own reasoning strategies and methods for solving problems. [18]

continued on next page

Ask students to discuss and explain why the procedures that they are using work to solve particular problems. [2]	Connect student-generated strategies and methods to more efficient procedures as appropriate. [30]	Use visual models to support students' understanding of general methods. [35]	Provide students with opportunities for distributed practice of procedures. [14]
Anticipate what students might struggle with during a lesson and be prepared to support them productively through the struggle. [21]	Give students time to struggle with tasks, and ask questions that scaffold students' thinking without stepping in to do the work for them. [15]	Help students realize that confusion and errors are a natural part of learning, by facilitating discussions on mistakes, misconceptions, and struggles. [25]	Praise students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems. [1]
Identify what counts as evidence of student progress toward mathematics learning goals. [20]	Elicit and gather evidence of student understanding at strategic points during instruction. [22]	Interpret student thinking to assess mathematical understanding, reasoning, and methods. [16]	Make in-the-moment decisions on how to respond to students with questions and prompts that prove, scaffold, and extend. [10]
Reflect on evidence of student learning to inform the planning of next instructional steps. [36]			

APPENDIX B

Administering the Q-Sort

- Each participant should have a large copy of the Q-grid with each cell large enough to fit one of the statement cards, the 37 Teacher Action cards cut, and a smaller 8.5” X 11” paper copy of the Q-grid to record their final sort.

- Be sure participants are seated at tables where they will have room to work independently and spread out the cards and the large copy of the Q-grid.

- Ask the participants to read the 37 Teacher Action cards independently and place each card in one of three piles: (a) actions most characteristic of their teaching, (b) actions least characteristic of their teaching, and (c) actions in between.

- Then ask the participants to take the statements from the three piles and place them one-by-one on the cells of the large symmetrical Q-grid. This requires the teachers to reflect further about the extent to which they enact each of the teacher actions in their classroom teaching.

- After the participants finish placing all of the statements on the large Q-grid, they are asked to record the placement of each statement on the smaller 8.5” X 11” version of the Q-grid for record keeping purposes (see Figure 2).

APPENDIX C

Advantages of Using the Q-sort	Disadvantages of Using the Q-sort
Non-evaluative	Time to complete (approx. 20-30 min)
Engaging activity	Results cannot be generalized to larger population
Can be used as a needs assessment tool	Need to prepare cards and grids
Visually informative	
More reliable than Likert-Scale survey	
Can be used as a reflection tool	
Promotes opportunities for discussion	
Can do with small to large groups of teachers	
Can obtain qualitative and quantitative results	

Elementary Mathematics Specialist Program: One State's Story of Development and Implementation

Stacy Reeder, *University of Oklahoma*
Juliana Utley, *Oklahoma State University*

Abstract

In this paper we present the development and implementation of the Oklahoma Elementary Mathematics Specialist certification pathway. The partnership among mathematics educators from several universities that led to the development and implementation of program requirements and coursework is shared. We also discuss the various challenges we faced throughout this process at the state and local levels. Finally, we provide evidence of the impact of these efforts from interviews of several teachers who completed the program.

Introduction

For the past several decades, Oklahoma has consistently ranked near the bottom of the states (most recently, 48th) for education quality which includes indicators for student achievement (Education Week, 2015). In 2013, the percentage of students in Oklahoma who performed at or above the Basic level on the National Assessment of Educational Progress (NAEP) was 68%, which represented a decrease from 2011, while only 25% of students performed at the NAEP Proficient level. In 2015-16, 43% of Oklahoma's new teachers were alternatively certified or emergency certified, meaning that nearly half of the new teachers had, at most, passed an exam to enter the classroom rather than successfully completed a teacher preparation program (Baines, Hannah, & Wickham, 2016). With this rate increasing each year, it is difficult to assess the mathematics background, not to mention the pedagogical content knowledge, of a significant portion of individuals now teaching mathematics in Oklahoma's classrooms. The need for improvement in education, mathematics teaching and learning in particular, and the need for mathematics leadership at all levels is paramount in our state. With these and similar concerns in mind, the state of Oklahoma began work to develop an Elementary Mathematics Specialist (EMS) certification pathway in 2009. As longtime members of the National Council of Teachers of Mathematics (NCTM) and the Association of Mathematics Teacher Educators (AMTE), we (the authors) were eager for the development and implementation of EMS programs in our state with the sincere hope that such a program could bring about improved mathematics teaching and learning at the elementary level.

We have been engaged in all aspects of the development of Oklahoma's EMS certification pathway, the program requirements, the university coursework (at four institutions), and the certification assessment exam. The development and implementation of the Oklahoma EMS certification pathway is a story of success regarding the program's impact on the participant teachers' leadership capacity, mathematics content knowledge, and pedagogical practices for teaching mathematics (Utley & Reeder, 2016). Unfortunately, it is also a story imbued with challenges related to policy, politics, accreditation, and resources. The purpose of this paper is to share our story of development and implementation of the Oklahoma EMS program. In doing so, we describe the challenges we encountered and the impacts of the program on the participant teachers' leadership capacity.

Background Literature

Elementary Teachers as Generalists

The need for improved elementary mathematics teaching and learning has long been a concern for the mathematics education community (e.g., Coleman & Selby, 1983; NCTM, 1989; Wu, 2009). Researchers have highlighted the urgent need to provide increased and more effective mathematics instruction at the elementary level (Coleman & Selby, 1983). The issue of improving both the teaching and learning of mathematics in pre-K-6 environments has been the subject of countless research studies focused on teacher content knowledge (e.g., Hill, Rowan, & Ball, 2005; Smith, Swars, Smith, Hart, & Haardoerfer, 2012), teacher beliefs about mathematics teaching and learning (e.g., Campbell & Malkus, 2011), and student learning (e.g., Bronson & Erchick, 2010). Further, the discussion about the need for leadership and specialists in mathematics at the elementary level has been a focus of the mathematics education community for decades (e.g., Dossey, 1984; Fennel, 2006; National Mathematics Advisory Panel [NMAP], 2008; Reys & Fennel, 2003).

The NCTM (2000), the AMTE (2013), the NMAP (2008), and the National Research Council (NRC, 1989) stated that most elementary teachers are generalists. Elementary teachers are prepared in their teacher certification programs to teach all core subjects, and as such, rarely have the opportunity to develop the depth of knowledge nor the skills required to teach elementary mathematics effectively. In the *2012 National Survey of Science and Mathematics Education*, Banilower and colleagues (2013) found that while 77% of elementary teachers surveyed reported that they felt well prepared to teach number and operations, only 56% felt the same when asked about measurement, 54% when asked about geometry, and 46% about early algebra. The cause of this uncertainty was often associated with elementary teachers' lack of preparation in mathematics. The authors of *Everybody Counts* (NRC, 1989) stated that "too often, elementary teachers take only one course in mathematics, approaching it with trepidation and leaving it with relief. Such experiences leave many elementary teachers totally unprepared to inspire children with confidence in their own mathematical abilities" (p. 64). The Conference Board of Mathematical Sciences (CBMS, 2012) added that elementary teachers specifically need a broader and deeper understanding of the mathematics they will teach, and they need to understand how the content they teach connects across topics and grades. With elementary teachers being prepared as generalists, Wu (2009) and the NMAP (2008) suggested that focusing on EMSs' content knowledge could be an alternative to the problem of increasing the content knowledge of all elementary teachers.

Elementary Mathematics Specialist Movement

Since the early 1980s, there have been recommendations for the development of EMSs. At their annual meeting in 1981, NCTM passed a resolution calling for state agencies to development certification credentials for EMSs. Since then, several NCTM presidents (e.g., Dossey, 1984; Lott, 2003; Fennell, 2006; Gojak, 2013) have also described the need for EMSs. Additionally, several seminal publications in mathematics education have called for the development of EMSs (e.g., CBMS, 2001; NCTM, 2000; NMAP, 2008; NRC, 2001). Each of these presidential messages and seminal publications noted the issue of the preparation of elementary teachers as generalists and the need for elementary schools to employ a mathematics specialist. More recently, a joint position statement of AMTE, the National Council of Supervisors of Mathematics (NSCM), NCTM, and the Association of State Supervisors of Mathematics (ASSM) indicated that:

> EMS professionals need a deep and broad knowledge of mathematics content, expertise in using and helping others use effective instructional practices, and the ability to support efforts that help all pre-K-6 students learn important mathematics. [Mathematics should focus] on mathematics content knowledge, pedagogical knowledge and leadership knowledge and skills. (para. 1)

Despite the longstanding concerns about the teaching and learning of mathematics at the elementary level, the formalization of pathways to develop EMSs is recent with pathways for EMS certification or endorsement established in only about twenty states (EMS & Teacher Leader Project, 2016; Rigelman & Wray, 2017). In 2010, with the support of ASSM, NCSM, and NCTM, and after considerable development, AMTE released their *Standards for Elementary Mathematics Specialists: A Reference for Teacher Credentialing and Degree Programs* (2010/2013). In this document, AMTE proposed that curriculum for the preparation of EMSs include content knowledge for teaching, pedagogical strategies for teaching, and leadership knowledge and skills.

Roles of Elementary Mathematics Specialists

Reys and Fennel (2003) defined EMSs as "teachers with particular knowledge, interest, and expertise in mathematics content and pedagogy" (p. 278). Although there are currently numerous programs for preparing EMSs across the nation, the preparation and the role that EMSs fill in schools varies significantly. These individuals may carry a variety of titles such as mathematics or instructional coach, mathematics interventionist, or elementary mathematics specialist. Swars, Smith, Smith, Carothers, and Myer (2016) revealed that EMSs' roles have been viewed from a variety of perspectives resulting in EMSs working primarily with students, teachers, or both students and teachers depending on context and need. The various roles that EMSs may inhabit in schools or districts played a significant role in the design of the Oklahoma EMS certification pathway.

EMSs may teach mathematics to students in one or more grades, provide remediation or enrichment for groups of students, or serve as instructional coaches at the school or district level (AMTE, ASSM, NCSM, & NCTM, 2013). In all of these roles, EMSs will typically provide support for teachers in their building or district through a variety of activities such as modeling lessons, providing resources and professional development, co-planning, co-teaching, analyzing student data, and developing curriculum.

> [Regardless of] the setting or responsibilities, EMS professionals need (1) deep and broad understanding of mathematical content, including the specialized knowledge needed for teaching, (2) solid knowledge of the elementary context, (3) expertise in using and helping others use effective instructional and assessment practices that are informed by knowledge of mathematical learning trajectories, (4) knowledge and skills for working with adult learners, and (5) leadership skills necessary to influence and support educational efforts to improve the teaching and learning of mathematics. (AMTE, ASSM, NCSM, & NCTM, 2013, p. 1)

Oklahoma's Elementary Mathematics Specialist Certification Pathway

In the state of Oklahoma, there are four main agencies (not including the Oklahoma State Senate and House of Representatives) that are involved in and govern matters related to teacher certification and licensure. The Oklahoma State Regents for Higher Education (OSRHE) and the Oklahoma State Board of Education (OSBE) along with the Oklahoma State Department of Education (OSDE) and the Oklahoma Education Quality and Accountability Board (OEQA) govern certain aspects of teacher certification. Since the EMS certification pathway in Oklahoma was developed as an add-on certification for teachers who have an undergraduate degree and are certified teachers, the work related to the development of EMS fell under the auspices of the OSRHE. Thus, in 2009, amidst the backdrop of the national discussion and effort focused on the important role of EMSs, the OSRHE formed a committee of teachers and university mathematics educators to begin development of the Oklahoma EMS certification pathway.

Standards Development

In 2010, following the release of AMTE's standards for EMSs, members from the Oklahoma team were invited to and attended the first States Certification Conference for Elementary Mathematics Specialists in Louisville, Kentucky supported by the Brookhill Institute of Mathematics. Shortly following that meeting, Oklahoma began the process of developing standards as well as the structure and criteria for the Oklahoma EMS certification program.

Rather than adopting the standards developed and vetted by AMTE, the OSRHE determined that Oklahoma should develop its own standards. This decision was consistent with past decisions by the state to develop its own versions of standards and teacher certification exams rather than use those that had been nationally developed and adopted by other states. Work to develop the Oklahoma EMS standards began in earnest in 2010 and involved the efforts of nearly 30 mathematics educators and teachers from universities, colleges, and school districts across the state of Oklahoma along with representatives from the OSRHE and the OSDE. Following months of development, the final draft of the Oklahoma EMS standards received input by education constituents and were reviewed by two independent national reviewers. In early 2012, the Oklahoma EMS standards were approved by the OSBE.

Program Requirements

During the standards-development process, efforts were coordinated among the OSRHE and the OSDE. The OEQA regulates the process for obtaining an Oklahoma EMS certification as well as the accreditation for universities offering the program. The group of mathematics educators and teachers working to develop the standards made the following recommendations for program candidates, institutions, and coursework requirements that were approved and adopted by the OSRHE and OEQA.

Candidate Requirements – must be met prior to beginning coursework:

- Valid teacher certification in Elementary Education and/or Early Childhood Education; and
- Two years of full-time teaching experience in grades pre-K through 5 at an accredited school under a valid state-issued teacher credential.

Institution Requirements:

- A state approved and/or nationally accredited Elementary Education or Early Childhood program.
- Regents' approval is required for state institutions offering the Oklahoma EMS coursework leading to a new master's degree as a Mathematics Specialist. Approval is not required if the coursework is an option for an existing master's level program. Or, governing body approval is required for private institutions.

Coursework Requirements:

- Eighteen hours of graduate level coursework is required. Institutions will determine the coursework for a candidate to satisfy the Oklahoma EMS competencies. . . . Criteria for the 18 hours are 60-70% focus on pedagogical mathematics content knowledge and 30-40% mathematics instructional leadership (see Figure 1).

Once the criteria for the coursework were approved and the standards adopted, universities were free to develop and implement the coursework required for the EMS program.

FIGURE 1.

Oklahoma EMS program content and pedagogy requirements

Domain No.	Domain Title	Credit Hours
I	Number Concepts and Operations	60-70%
II	Algebra and Functions	
III	Geometry and Measurement	
IV	Data Analysis and Probability	
V	Mathematics Instructional Leadership	30-40%
Total (%)		100%
Total (Credit Hours)		18

Our Vision for EMS Certification Programs in Oklahoma

The state of Oklahoma has an expansive university and college system including two large research universities, six regional universities, and numerous state-funded colleges, community colleges, and private colleges. We are both mathematics educators at the research universities (University of Oklahoma and Oklahoma State University) and have been involved in the Oklahoma EMS work since it began in the state. Additionally, we also attended AMTE pre-conference workshops with Francis "Skip" Fennell (former NCTM President and Director of the Elementary Mathematics Specialists and Teacher Leaders Project) in anticipation of developing the coursework for the certification program. We were eager for the Oklahoma EMS programs to be strong and credible and knew that our colleagues at the regional universities planning to offer this program would agree.

Oklahoma Mathematics Educators Partnership

Considering our desire to develop strong EMS programs in the state and recognizing that there were only one or two mathematics educators at each university, we formed a group that ultimately included the two of us and a mathematics educator from each of two regional universities. The purpose of this partnership was to provide support for one another in the envisioning and development of 18 hours of graduate coursework and other program requirements. In addition to having attended EMS workshops at

AMTE annual conferences, we also contacted colleagues from across the nation who had successful EMS programs and asked if they might be willing to share their syllabi and other program information.

Our small group began meeting in summer 2012 to develop the course syllabi, portfolio requirements, and field experience expectations. Using the course syllabi shared with us from the North Carolina university system, these conversations and work sessions were robust and motivated by the hope and belief that implementing EMS programs in Oklahoma could create significant change for mathematics teaching and learning at the elementary level. We believed then, and still do, that developing EMSs is an answer to address many of the profound challenges we face in improving mathematics teaching and learning at the elementary level.

After many hours of meetings in people's homes over the summer and working digitally between the meetings, we developed several key goals for our EMS program and ideas about how we would meet those goals through six graduate-level courses. We decided five courses would be content and pedagogy focused, and one would be focused on leadership development. In addition to coursework discussions, we determined that the program would be comprised of essential assignments to be repeated throughout each content/pedagogy course with a change in the mathematical content focus (e.g., teachers would develop and locate high cognitive demand tasks and develop a literature review in each course). In addition, a list of other program activities and experiences was developed. We also created a portfolio assignment to provide an opportunity for teachers not only to display the essential assignments from the program but also to document the other required experiences and activities they should accomplish by the end of the program (e.g., submit a grant application for materials for their classroom, develop and present a professional development session for teachers in their building, or mentor a new teacher in their building specifically focused on the improvement of mathematics teaching and learning). Finally, considerable time and thought was given to developing meaningful and appropriate expectations for the 30-hour field experience required for the program by the state guidelines. We determined that the field experience would be best embedded in the leadership course. Given that the teachers in the program would all be practicing classroom teachers, a menu of items/experiences was developed to help them meet the 30-hour expectation (e.g., observe an expert elementary mathematics teacher in another building/district, lead a group of teachers in their building in a book discussion, or work with a group of students not in their class on mathematics for intervention or improvement).

Consideration of the goals and aspirations of the OEMS program to develop elementary mathematics leaders whose content and pedagogical knowledge would be deepened and strengthened led to the development of six courses focused on the following main topics and ideas*:

- Algebra and Mathematical Tasks;
- Geometry, Spatial Visualization, and Learning Trajectories;
- Data Analysis, Measurement, and Instructional Technology;
- Number Concepts and Assessment;
- Rational Number Concepts, Proportional Reasoning, and Classroom Interactions; and
- Mathematics Leadership and Coaching (includes a minimum of 30 hours of field experience).

*Course titles vary to some degree from institution to institution.

Each course, with the exception of the leadership and coaching course, focused on certain mathematics content paired with a pedagogical practice or aspect of effective mathematics teaching. To meet both the content and pedagogical goals and objectives for each course while also keeping the goals and aspirations of the program related to content, pedagogy, technology, and leadership in mind, considerable thought was given to how best to engage teachers in each course. For example, the course focusing on geometry, spatial visualization, and learning trajectories included the following goals and objectives for both content and pedagogy:

Content-focused outcomes:

1. Demonstrate content knowledge in K-8 geometry based upon national standards (i.e., Common Core State Standards for Mathematics and National Council of Teachers of Mathematics).
2. Describe geometric shapes and properties, location, transformations, and spatial relationships/visualization.

3. Understand the relationship between two-dimensional and three-dimensional shapes, perimeter and surface area, and area and volume.

Pedagogy-focused outcomes:

1. Compare and contrast various mathematics pedagogies for teaching geometry and spatial visualization.
2. Explain a variety of appropriate teaching methodologies for mathematics.
3. Use appropriate technology to support student learning of geometry and measurement.
4. Evaluate and analyze student thinking using the van Hiele Levels of Geometric Thinking.
5. Evaluate and identify a variety of appropriate instructional strategies to assist elementary children in developing an understanding of geometric concepts.
6. Identify and describe the learning trajectories for mathematics for pre-K through 6th grade students.
7. Compile different assessment strategies that will measure student learning and understanding as well as inform teacher decision making.
8. Identify the ways to help students connect the geometry and measurement content they are learning to their existing mathematical knowledge, to other disciplines, and to their world.

When our group considered the experiences we wanted for the teachers in this program related to content, we heeded the CBMS (2012) calls for change in how teachers of mathematics are prepared. They suggested:

> A major advance in teacher education is the realization that teachers should study the mathematics they teach in depth, and from the perspective of a teacher. There is widespread agreement among mathematics education researchers and mathematicians that it is not enough for teachers to rely on their past experiences as learners of mathematics. It is also not enough for teachers just to study mathematics that is more advanced than the mathematics they will teach. Importantly, mathematics courses and professional development for elementary teachers should not only aim to remedy weaknesses in mathematical knowledge, but also help teachers develop a deeper and more comprehensive view and understanding of the mathematics they will or already do teach. (p. 23)

Continuing with the example of the course focused on geometry and learning trajectories, we aimed to engage the teachers in our program in geometry content relevant to the mathematics they teach and help them develop a deeper and more comprehensive understanding of that mathematics. In order to meet these goals and objectives, the course was designed to engage teachers in mathematics problem solving each week using problems and activities from Serra's (2002) *Discovering Geometry* (3rd edition) textbook. Throughout the semester, we planned for the teachers in this course to work several problems assigned from the text outside of class to be discussed the following week in class. We developed a list of web sources that would aid the teachers in understanding the content and/or refresh their memory of the particular topic if we did not have enough time to address each concept in class. Given that most teachers in these courses would have experience with the mathematics content presented in our courses, it was important to us that we not spend considerable time teaching mathematical concepts as if they were new to the teachers but rather consider ways to refresh, deepen, and expand the teachers' mathematics content knowledge. To meet this aim, careful thought was put into the pedagogical tasks that would be utilized in class as well as the readings focused on pedagogic practices.

The pedagogically focused materials and activities were purposefully selected in order to support teachers in not only improving their teaching practice but also developing their understanding of key mathematics concepts. The use of Quickdraw (Wheatley, 2007) provides a specific example. Quickdraw images would be used on a regular basis throughout the course to model for teachers how to utilize them as an effective classroom opener to develop their own students' spatial sense, definitions of a variety of shapes, and understanding of characteristics and classifications of a variety of shapes. Further, teachers would experience how quickdraw images can aid in the development of sociomathematical norms (Yackel & Cobb, 1996) that include communicating, listening, and honoring other's perspectives in mathematics class. Beyond learning how quickdraw images can be used with their own students, however, the plan for their use in our classes would be to develop many of those same understandings with and for our teachers. In this way, the use of quickdraw images can help to model and teach effective pedagogical practices while also deepening and extending the teachers' mathematical understanding and helping to develop their spatial sense. Since the pedagogical focus of this course was learning trajectories, not all work with learning trajectories would be focused on geometry concepts, but an emphasis on geometry would be utilized when possible to help support the teachers' understanding of geometry mathematical content.

Several texts were selected for use across all courses. The readings from those texts were organized so that they were applicable to the course, and so that by the end of the program, teachers would have read the entirety of the text. For example, in the geometry and learning trajectory focused course mentioned previously, both *Math Matters: Understanding the Math You Teach, grades K-8* (2nd Edition) by Chapin and Johnson (2006) and *Learning and Teaching Early Math: The Learning Trajectories Approach* by Clements and Sarama (2009) were used. Teachers would read most of the learning trajectories text for this course but then return to it throughout all other courses in the program as they developed tasks for their students. In contrast, readings and activities from the *Math Matters* text were selected as they related to each course. As such, the teachers would utilize the *Math Matters* text in each content- and pedagogy-focused course in the program. Developing teachers' use of technology was handled similarly. Teachers would be required to purchase *Geometer's Sketchpad* in the first course and then, when applicable, purchase accompanying books with explorations related to the content focus in some of the other courses.

The leadership course was designed as a culminating experience for teachers in the program and as such, four of the five content/pedagogy courses would be required for teachers prior to taking the leadership course. As our group planned for this course, we thought about not only the readings that would expand our teachers' understandings of what it means to be a teacher leader and how to work effectively as an elementary mathematics specialist in a variety of roles, but also about the experiences that would help the teachers develop as leaders in various capacities. Although teachers would be working throughout the program to accomplish the various experiences and leadership tasks provided for them at the onset of their first class, the leadership course would be the place and time that those experiences would culminate. For example, teachers could choose to present at the annual conference for the Oklahoma Council of Teachers of Mathematics (OCTM) but would be required to present a professional development session for teachers in their building. Since we face tremendous funding challenges in our state, teachers would be required to explore grant funding possibilities and apply to combat the common refrain, "We do not have math manipulatives." If teachers had not accomplished this expectation prior to the leadership course, it would be required to be completed by the end of the leadership course. Teachers would document these accomplishments and experiences in their portfolios.

As the group began to pull these ideas together in the form of syllabi and course materials we utilized Dropbox™ to aid in the process. Additionally, we successfully worked to implement the programs at more than one of our universities so that we could launch them at the same time and offer the same courses in the same semester thus supporting continued collaboration. This concurrent implementation of the programs was incredibly beneficial. Offering the courses simultaneously allowed us to remain in relevant conversation via phone and digital meetings throughout the program implementation and help one another as the courses unfolded and unforeseen challenges and concerns arose.

Challenges

Throughout the development and implementation of the OEMS certification pathway and programs, we were met with numerous challenges that are worth mentioning. From the decision by the OSRHE to have us develop our own standards to the limited resources for recruiting and incentives for teachers to pursue the EMS certification, this process was wrought with challenges that have left us almost a decade later asking how do we sustain these programs and how do we move forward.

In our opinion, the decision by state entities to develop standards for Oklahoma rather than simply adopting AMTE's *Standards for Elementary Mathematics Specialists: A Reference for Teacher Credentialing and Degree Programs* (2010, 2013) presented the first challenge in this process. Developing standards is arduous and time consuming, particularly when those standards will be the basis for a summative certification exam. Because we have several entities involved in teacher certification in Oklahoma, the development of the standards was led by the OSRHE, but the development of the certification exam was under the auspices of OEQA. The fact that different entities oversee different aspects of teacher certification naturally creates an opportunity for challenges with communication and that was certainly the case in this process. Additionally, since OEQA was not involved in the standards-writing process, there was not as much consideration given to the fact that the standards would provide the parameters for the certification exam. If that had been an integral part of our discussions while developing the standards, we suspect that we might have developed a slightly different document.

The final challenge, or perhaps frustration, related to our development of standards for Oklahoma was the fact that there is policy in Oklahoma that indicates that when a national education organization develops standards for a certification area we must defer to those standards. So, amidst our work with EMS candidates in our programs, with all coursework aligned to the Oklahoma EMS standards, NCTM released accreditation standards for EMS programs. At that point, all universities in Oklahoma were required to submit an accreditation report aligned to the NCTM EMS standards for advanced programs even though our programs were not developed to meet the NCTM/Council for the Accreditation of Education Preparation (CAEP) standards (2012). This policy is enforced by the OEQA. Despite our discussions with them regarding the fact that the Oklahoma EMS certification pathway is an add-on certification (18 hours of graduate coursework) and not an advanced certification (typically hours equivalent to a master's degree) we have not gained traction with the idea that trying to meet the NCTM EMS standards for advanced certification is not appropriate for our programs. This immediate deference to the NCTM CAEP standards also brings us back to our original challenge in this process – why did we not simply adopt the AMTE EMS standards in 2009? Due to the requirement that all Oklahoma EMS programs meet accreditation standards set forth by NCTM, no EMS program in the state received accreditation recognition following the first submission of accreditation reports. Although this was incredibly disappointing and concerning for sustainability, it was not surprising since the programs were not developed to meet the NCTM EMS standards and the certification exam was aligned to the Oklahoma EMS standards.

Recruitment and sustainability have been an ongoing challenge throughout this process due to several factors and surprises. First, during the development of the standards, there was much discussion with the OSRHE and OSDE regarding incentives and legislation regarding the addition of EMSs in our state. A tremendous amount of hope for these programs was placed on the idea that the OSDE and other entities would work together to incentivize this certification for teachers. For example, we discussed at length the need for stipends to support teachers pursuing this certification, that schools would be required to offer additional pay for individuals working with this certification, and that schools could only fill their mathematics support positions with individuals who had the EMS certification or were working towards the certification. Additionally, since our EMS certification programs were designed to develop individuals who could work in a variety of EMS roles, we imagined that many teachers would remain as classroom teachers after becoming an EMS so we discussed at length the idea that teachers of fourth- and fifth-grade mathematics be required to attain this certification. At the time, concerns about meeting the expectations of the Common Core (Common Core State Standards Initiative, 2010) was a tremendous motivator for consideration of departmentalization of fourth and fifth grade for mathematics so this seemed like a reasonable expectation for those teachers. This discussion occurred primarily during the standards and program expectation development process with OSRHE with OSDE representatives in the room. Unfortunately, that strong recommendation from the mathematics educators and teachers in the state was not considered or communicated to the OSDE for consideration.

When the development of all aspects of the programs was complete and universities were ready to implement the coursework, we were left with many failed promises. There were no financial incentives for teachers to pursue the EMS certification. No state level entity followed through with a stipend for teachers to pursue the certification. There was no expectation that teachers who work as mathematics support personnel be required to have the EMS certification. There was no additional pay for teachers with EMS certification. There was no discussion regarding departmentalization of fourth- and fifth-grade mathematics. The work of recruiting and promoting the EMS certification fell completely to the university mathematics educators.

Recruiting began for programs at six universities in Spring 2012 immediately following the approval of the Oklahoma EMS standards. One university planned to offer all coursework online while the others planned to offer all coursework in a face-to-face format. All four universities described earlier who collaborated to develop program coursework offered all coursework in a face-to-face format. The initial response to recruiting in terms of teacher interest was overwhelming. Based on interest alone, it seemed that we would have more teachers eager to begin the programs than we could handle. Unfortunately, that was ultimately not the case. Both of our universities had to postpone the kickoff of our programs due to low enrollment numbers. All those interested teachers had heard that there would be incentives associated with this certification and with the coursework. Sadly, initial interest in the EMS programs waned when teachers realized there would be no financial incentives tied to the certification or coursework. The University of Oklahoma had only eight teachers in the first class while Oklahoma State University had 12 in its first class. Given there were no stipends offered by the state for teachers pursuing this certification, both of us worked with our universities to have something to offer teachers by way of financial help. At the University of Oklahoma, we secured donor funding so each teacher could have a small stipend to help cover tuition for the first three semesters and at Oklahoma State University teachers interested in applying the 18 hour of EMS coursework towards a master's degree were eligible to apply for the TEACH grant. Although the programs got off the ground slowly in 2013, to date five universities have offered the program with approximately 30 teachers having been credentialed as EMSs.

Impact of Program

Given that the development of EMS programs is still a relatively new enterprise in a majority of states, more research on the impact of EMSs is needed (de Araujo, 2015). Although scant, the research available reveals that EMS programs and EMSs have a positive impact on teachers and students (Utley & Reeder, 2016; Campbell, 1996; McGatha, 2009; Polly, 2012). Several studies have found improvements in mathematics teaching and learning related specifically to an increased focus on problem solving and reasoning, use of formative assessment to guide instruction, effective planning, and student achievement because of EMSs' work in schools (Brosnan & Erchick, 2010; Campbell, 1996; Campbell & Malkus, 2011; McGatha 2009; Race, Ho, & Bower, 2002). Our research has shown that the Oklahoma EMS program had an impact through developing teachers' understanding of teacher leadership, increasing teacher leadership activity, deepening and extending teachers' mathematics content knowledge, and improving teacher confidence in their mathematical understanding (Utley & Reeder, 2016).

The EMSs from our programs attest to the impact of the program on their mathematics understanding and content knowledge as well as their pedagogical practices. When asked if the Oklahoma EMS program had impacted her as a teacher, one teacher shared:

> I just believe in the program so much because not only has it changed my math teaching, but it has also changed the way I teach across the board. Just questioning and asking kids instead of just telling. It's changed my whole philosophy. . . I think the biggest thing is that I feel like a new teacher. I feel it has rekindled my passion and rekindled my excitement. At this point in your career, when you have only about 10 years left, that's a big deal. . . I love teaching and I love students, but I'm not too happy with the status quo. I'm out there trying to learn, and I'm out there still feeling like there is more. Before I thought that I had it right. I thought I was doing everything I was supposed to do. I was doing it. I was doing it every day. Now it's like there's more. There's more.

Another teacher discussed her better understanding of productive struggle for her and her students.

> I definitely felt productive struggle several times and I realized productive struggle is okay and it's necessary and I need to allow students to have that. But there is a balance and I think that . . . I've been working with a teacher right now who hasn't found that balance yet. Her kids leave her classroom totally frustrated.

Finally, a third teacher shared her thoughts about how the program impacted her as a teacher.

> There is [*sic*] so many things that I have changed. For instance, I've started to try things like differentiated instruction and come up with activities for the different levels and abilities of my students. I feel like I'm more aware of how children learn and what they need to learn and how they need to learn it and what's more important in teaching them math. . . . So, I'm more aware of what they need to know in the long run to help them understand math, to really know math. I want them to really know it, not just know the steps.

These teachers' testaments to the impact of the program on their teaching and work with students and other teachers is consistent with all the teachers who have completed our programs to date. Although this is anecdotal evidence, it is evidence nonetheless that these 18 hours of graduate credit developed to prepare EMSs in Oklahoma have had a powerful impact on the teachers involved and have empowered them to work as elementary mathematics leaders in our state.

Concluding Remarks

We agree with Wu (2009) that the way to improve the mathematics teaching and learning at the elementary level in our state is to develop a cadre of teachers who have an interest and expertise in mathematics content and pedagogy. Ball, Hill, and Bass (2005) suggested that little will improve with student mathematics achievement unless significant attention is given directly to the practice of teaching mathematics and the development of teacher content knowledge needed for teaching mathematics. We believe that EMS programs can meet both these expectations. Gojak (2013), a past NCTM president, shared several reasons why the mathematics education community should continue to support EMSs in schools. Among these reasons was the idea that EMSs could impact professional learning communities by providing professional development for teachers focused specifically on teachers' interests and needs. She also suggested that EMSs in schools can help meet the needs of diverse learners and would have the pedagogical and mathematical knowledge necessary to help children develop deep and flexible understandings of mathematics.

Despite the challenges we faced throughout the program development and implementation, we believe, now more than before we began in 2009, that the EMS certification programs in Oklahoma hold tremendous promise. Our program, as outlined in this paper, represents one model for delivering a specialized program for the development of EMSs. Certainly, more research is needed on how best to deliver such programs and on what content is most effective and necessary (de Araujo, 2015). However, even without empirical evidence of the impact of our programs at this stage, the anecdotal evidence is strong in the words of our state's EMSs. Many of them have been transformed from strong classroom teachers in their building and district to elementary mathematics leaders in our state. From among the first small group of teachers who completed our programs, several present every year at the OCTM conference, several provide professional development specifically for elementary mathematics across the state, several work as EMSs in their buildings, and several now run social media sites that support professional learning communities both locally, in the state, and beyond. We believe these programs developed "teachers with particular knowledge, interest, and expertise in mathematic content and pedagogy" (Reys & Fennell, 2003, p. 278), who will work as teacher leaders in their classrooms, their buildings, their districts, and our state, to bring about change in the way mathematics is taught and learned at the elementary level. Further, each EMS reported throughout the program coursework that their work with students was improved as they implemented teaching practices that reflected what they were learning in the program.

We will remain steadfast advocates for these programs but sadly, due to failed promises related to incentives and policy changes to support the EMS programs in our state, the few mathematics educators (and their universities) in our state are left alone to shoulder the investment needed for the continued preparation of EMSs. This leaves us with several important questions about how to sustain the important endeavor of developing EMSs in our state and nation: How do we best recruit and encourage elementary teachers to pursue the EMS certification? If we believe that developing EMSs in our state is key to significant change for the mathematics teaching and learning of children in our state, how do we rally the education entities in our state to help us move forward? Are there ways that mathematics educators and school mathematics leaders in the nation working on and in these programs can support one another around issues of advocacy for elementary mathematics teaching and learning? Although our story of development and implementation of the Oklahoma EMS program was laced with challenges, we overcame many of them and developed several EMSs who are now providing much needed leadership in our state for elementary mathematics. The worthwhile and significant work of developing EMSs will continue in our state, and perhaps we can find ways to work together and support one another across the nation to address the challenges that remain. ✪

References

Association for Mathematics Teacher Educators. (2010/2013). *Standards for elementary mathematics specialists: A reference for teacher credentialing and degree programs.* San Diego, CA: Author.

Association of Mathematics Teacher Educators, Association of State Supervisors of Mathematics, National Council of Supervisors of Mathematics, & National Council of Teachers of Mathematics. (2013). *The role of elementary mathematics specialists in the teaching and learning of mathematics.* Retrieved from https://amte.net/group/resources/12-13/position-role-elementary-mathematics-specialists-teaching-and-learning-mathema

Baines, L., Hannah, J., & Wickham, A. (2016). *Alternative teacher certification: An update.* Paper presented to the Oklahoma State Legislature. October 4, 2016.

Ball, D. L., Hill, H. C., & Bass, H. (2005). Knowing mathematics for teaching: Who knows mathematics well enough to teach mathematics and how can we decide? *American Educator, 29*(3), 14 - 22.

Banilower, E. R., Smith, P. S., Weiss, I. R., Malzahn, K. A., Campbell, K. M., & Weis, A. M. (2013). *Report of the 2012 National Survey of Science and Mathematics Education.* Chapel Hill, NC: Horizon Research, Inc.

Brosnan, P., & Erchick, D. (2010). Mathematics coaching and its impact on student achievement. In the *Proceedings of the Psychology of Mathematics Education – North America.* Columbus, OH: PME-NA.

Campbell, P. (1996). Empowering children and teachers in the elementary mathematics classrooms of urban schools. *Urban Education, 30*, 449–475.

Campbell, P. F., & Malkus, N. N. (2011). The impact of elementary mathematics coaches on student achievement. *The Elementary School Journal, 111*, 430-454. doi: 10.1086/657654

Chapin, S. H., & Johnson, A. (2006). *Math matters: Understanding the math you teach, grades k-8* (2nd ed.). Sausalito, CA: Math Solutions.

Clements, D. H., & Sarama, J. A. (2009). *Learning and teaching early math: The learning trajectories approach.* New York, NY: Routledge.

Coleman, W. T., & Selby, C. C. (1983). *Educating Americans for the 21st Century: A plan of action for improving mathematics, science and technology education for all American elementary and secondary students so that their achievement is the best in the world by 1995.* Washington, DC: National Science Foundation.

Common Core State Standards Initiative. (2010). *Common core state standards for mathematics.* Washington, DC: National Governors Association Center for Best Practices and the Council of Chief State School Officers.

Conference Board of the Mathematical Sciences. (2001). *The mathematical education of teachers.* Providence, RI and Washington, DC: American Mathematical Society and Mathematical Association of America.

Conference Board of the Mathematical Sciences (2012). *The mathematical education of teachers II.* Providence, RI and Washington, DC: American Mathematical Society and Mathematical Association of America.

de Araujo, Z. (2015). The need for research into elementary mathematics specialist preparation. *Journal of Mathematics Education Leadership, 16*(2), 27-37.

Dossey, J. A. (1984). One point of view: Elementary school mathematics specialists: Where are they? *Arithmetic Teacher, 32*(3), 3-50.

Education Week. (2015). *Quality counts.* Retrieved from http://www.edweek.org/media/qualitycounts2015_release.pdf.

EMS & Teacher Leader Project. (2016) [Graph illustration and descriptions by state]. Mathematics Specialist Certification (by State). Retrieved from http://www.mathspecialists.org/state-certifications.html.

Fennel, F. S. (2006). President's message: We need elementary school mathematics specialists NOW. *NCTM News Bulletin, 43*(4), 3.

Gojak, L. (2013). *It's elementary! Rethinking the role of the elementary classroom teacher*. Retrieved from http://www.nctm.org/News-and-Calendar/Messages-from-the-President/Archive/Linda-M_-Gojak/It_s-Elementary!- Rethinking-the-Role-of-the-Elementary-Classroom-Teacher/

Hill, H., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Education Research Journal, 42*, 371-406.

Lott, J. (2003). The time has come for pre-k–5 mathematics specialists, *NCTM News Bulletin, 40*. Retrieved from http://www.nctm.org/about/content.aspx?id=956.

McGatha, M. (2009). *Mathematics specialists and mathematics coaches: What does the research say?*. NCTM Research Briefs. Retrieved from http://nctm.org/uploadedFiles/Research_News_and_Advocacy/Research/Clips_and_Briefs/Research_brief_13_coaches.pdf

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2012). *Elementary math specialist advanced preparation program standards.* Retrieved from http://www.nctm.org/standards-and-positions/caep-standards/.

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel.* Washington, DC: U.S. Department of Education.

National Research Council. (1989). *Everybody counts: A report to the nation on the future of mathematics education.* Washington, DC: National Academy Press.

National Research Council. (2001). *Adding it up: Helping children learn mathematics.* J. Kilpatrick, J. Swafford, and B. Findell (Eds.). Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.

Polly, D. (2012). Supporting mathematics instruction with an expert coaching model. *Mathematics Teacher Education and Development, 14*(1), 78-93.

Race, K. E., Ho, E., & Bower, L. (2002). *Documenting in-classroom support and coaching activities of a professional development program directed toward school-wide change: An integral part of an organization's evaluation efforts.* Paper presented at the annual meeting of the American Education Research Association, New Orleans, LA. Retrieved from http://www.raceassociates.com/materials/AEA2002b.pdf.

Reys, B. J., & Fennell, F. (2003). Who should lead mathematics instruction at the elementary school level? A case for mathematics specialists. *Teaching Children Mathematics, 9*, 277-282.

Rigelman, N. R., & Wray, J. A. (2017). Current state of mathematics specialist state certification and standards. In M. B. McGatha & N. R. Rigelman (Eds.), *Elementary mathematics specialists: Developing, refining, and examining programs that support mathematics teaching and learning.* Charlotte, NC: Information Age Publishing.

Serra, M. (2002). *Discovering geometry* (3rd ed.). Emeryville, CA: Key Curriculum Press.

Smith, M. E., Swars, S. L., Smith, S. Z., Hart, L. C., & Haardoerfer, R. (2012). Effects of an additional mathematics content courses on elementary teachers' mathematical beliefs and knowledge for teaching. *Action in Teacher Education, 4*, 336–348. http://dx.doi.org/10.1080/01626620.2012.712745

Swars, S. L., Smith, S. Z., Smith, M. E., Carothers, J., & Myer, K. (2016). The preparation experiences of elementary mathematic specialists: Examining influences on belief, content knowledge, and teaching practices. *Journal of Mathematics Teacher Education.* Advance online publication. doi: 10.1007/s10857-016-9354-y

Utley, J., & Reeder, S. (2016). Developing leadership capacity: The impact of an elementary mathematics specialists program. Abstract published in *Proceedings of the 39th Annual Meeting of the Psychology of Mathematics Education* – North American Chapter, Tucson, AZ.

Wheatley, G. (2007). *Quick draw* (2nd ed.). Tallahassee, FL: Mathematics Learning.

Wu, H. (2009). What's sophisticated about elementary mathematics. *American Educator, 33*(3), 4-14.

Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education, 27*, 458-477.

Teacher Time Out: Educators Learning Together In and Through Practice

Lynsey Gibbons, *Boston University*
Elham Kazemi, *University of Washington*
Allison Hintz, *University of Washington Bothell*
Elizabeth Hartmann, *University of Fukui*

Abstract

Improving professional learning for educators is a crucial step in transforming instruction and providing students with rich opportunities to learn mathematics. This study examined an organizational routine, Teacher Time Out, *that emerged in a school-wide professional development effort to improve learning opportunities for students in mathematics. The routine is enacted when teachers and school leaders design and enact lessons together with students present, pausing regularly within the lesson to think aloud, share decision-making, and/or determine where to steer instruction. Drawing from a larger data set, we conducted a fine-grained analysis that examined multiple Teacher Time Out episodes from one full day of professional development for elementary mathematics teachers. The findings delineate the potential of the routine to support the learning of educators and the formation of school-wide community. Implications for designing professional learning opportunities that support mathematics teachers to learn collectively about practice in the midst of authentic teaching settings are discussed.*

Introduction

Imagine a team of elementary teachers, school leaders, and teacher educators regularly coming together for a daylong, job-embedded professional learning event. They discuss what students need to know about a particular mathematical idea and design an instructional task they believe will support students in learning to reason about mathematics. With plans in hand, they walk into one of their classrooms to try out the lesson together with their students. All of the teachers are responsible for teaching. As the team aims to be responsive to the mathematical ideas that students raise, they will think together, in the moment, about how to steer the lesson and make suggestions for what to do next. Working together, they attend carefully to how students are engaging with each other and the mathematical ideas. All members of the team know they have permission to pause instruction, by taking a *Teacher Time Out* (TTO), to think aloud together and consider their instructional decisions before continuing with the lesson.

As we will explain, TTOs enable teachers and leaders to take collective responsibility for a lesson, as it *unfolds*, and give them permission to pause within the lesson to think aloud, share decision-making with one another, and/or determine where to steer instruction. By using TTOs to consider and make changes in the moment, there is less of a need to reflect hypothetically after the fact by asking, "What would have happened if we had just done or said *x*?"

Instead, TTO interactions shift the focus from one of judgment and evaluation to one of collective consideration and opportunistic experimentation in the midst of teaching mathematics. Through an analysis of a representative lesson in which several TTOs were taken, we aim to contribute to the growing body of research focused on understanding the possibilities for improving mathematics instruction that reside in professional communities and classroom-based learning experiences.

Cultivating Professional Inquiry and Learning

In our work with teachers and school leaders, we are interested in generating opportunities for them to plan for and enact practices together while students are present. We desire to support teachers in using insights they acquire while engaging in professional development away from classrooms (where they rely on artifacts like videos of instruction or student work) into practice (where they can respond immediately to students' thinking). We view the TTO routine to be what Grossman et al. (2009) called a *pedagogy of enactment*, and our analysis contributes to building a literature base for it.

Toward a Vision for Ambitious Teaching

Over the past two decades, prominent professional organizations have articulated goals for students' learning (e.g., Common Core State Standards Initiative, 2010; National Council of Teachers of Mathematics [NCTM], 1989, 2000). These goals emphasize both conceptual understanding and procedural fluency in a range of mathematical domains, the use of multiple representations, mathematical argumentation to communicate mathematical ideas effectively, and productive dispositions toward mathematics (U.S. Department of Education, 2008; Kilpatrick Swafford, & Findell, 2001; NCTM, 2000). These goals for student learning have implications for what mathematics teachers need to know and be able to do.

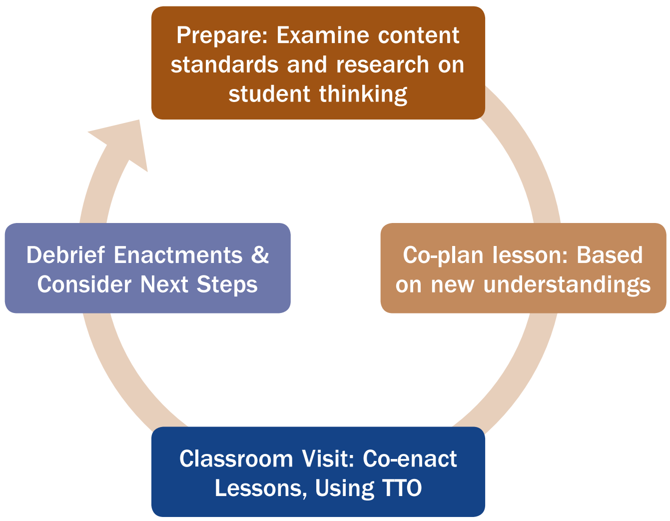
To this end, mathematics teachers need to learn to elicit, observe, and interpret student reasoning, language, and arguments, and to adapt tasks and instruction in response to students in order to promote learning (Franke, Kazemi, & Battey, 2007; Kazemi & Stipek 2001; Silver & Smith 1996; Stein, Grover, & Henningsen 1996). Teaching in this way cultivates learning environments where all students can do substantive mathematics and are treated as sense-makers (Lampert et al., 2013). For us, this vision of mathematics teaching and learning sits within and pushes back against everyday experiences of societal and school structures that have typically labeled and sorted children and schools as being capable or not. We aim to give voice to students' and teachers' experiences. In our work with teachers and leaders, we want to create schools where children and adults are known and cared for, as well as where they feel invested (Martin, 2009). The work we describe in this article is part of advancing an equity agenda where students' and teachers' multiple knowledge bases are seen as assets rather than deficits (Aguirre, Mayfield-Ingram, & Martin, 2013; Turner et al., 2012).

Math Labs: A Job-Embedded Professional Learning Design

In a research-practice partnership, we have worked with school leaders to co-develop school-wide professional learning structures, which are informed by the wide body of research on how students learn mathematics, how teachers develop ambitious practices, and how to develop effective institutional support for that development. The professional learning structure highlighted in this article is called math labs, which are either half-day or day-long gatherings of grade-level teams, instructional specialists, and the principal, facilitated by a school-based coach. The aims of the professional development included cultivating a principled vision of ambitious teaching in elementary mathematics with specific tools and practices that could be implemented school-wide to promote teacher and student learning. TTOs emerged within math labs.

There are four parts of a math lab: (1) unpacking ideas about teaching and learning mathematics, (2) co-planning instruction, (3) co-enacting instruction during classroom visits, and (4) reflecting on the enactment, the teachers' learning, and the planning for future instruction (see Figure 1). In the examples we write about in this article, the mathematics coach and a university-based teacher educator typically co-facilitated the math lab. As the mathematics coach learned the math lab structure, she facilitated the learning experience for teachers on her own. Primed with particular content and student learning ideas, the team engaged in a cycle of collaborative planning, enactment, and reflection around an instructional activity (see Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010).

FIGURE 1.
Overview of the structure of Math Lab



Significant and distinctive to the professional learning design were the two classroom visits during the math labs and the ways in which these visits were conducted. By design, classroom visits were exploratory in nature. They gave teachers opportunities to take risks and try out new instructional practices. The visits took place in the classroom of a teacher who was participating in the math lab. The guest substitute teacher would step aside to allow the team to co-enact the lesson.

The visits allowed for the team (i.e., the teachers, specialists, the coach, the principal, and the university facilitator) to engage in joint inquiry around mathematical concepts, student thinking, and particular pedagogies that support students' learning. During the co-planning before the classroom visit, the team considered the mathematics and focal pedagogical practices that they wished to use to support student learning. During the visit, the team's role was to bring the lesson to life and to listen closely to student thinking in order to consider how to orchestrate instruction to be productive for students. Because the tone of classroom visits was one of experimentation and playful curiosity about students' thinking, one team member typically began the lesson and others interjected opportunistically during the lessons. After the first classroom visit, the team debriefed the lesson before making a second visit to a different classroom. After the second visit, another debrief conversation was focused on what the team learned about students' mathematical ideas and how their instructional practices influenced student learning.

Educators who hear about TTO for the first time often wonder what the impact of TTO is on students and their learning. Although we do not have systematic data to answer this question, we can speak to our experiences over many years and many schools in how students typically respond. We have found that students enjoy the experience of having many teachers listen carefully to their thinking and work together within TTOs to make sense of their thinking. Because the lesson is portrayed as playful, students look forward to classroom visits and look wide-eyed as the team enters the classroom, often counting how many adults have entered the room. Before the lesson begins, the team thanks the students in advance for their assistance on this special day and positions them as the true teachers since they will help teachers learn. Many teachers remark that they appreciate how the TTO positions them as learners and further develops their classroom community as a place where people work together to support each other's learning. Often, students are curious about what the teachers are talking about and may even have suggestions for teachers on how to proceed: "We think you should do this," or "Do you want to take a teacher time out?" TTO discussions are relatively short (typically taking anywhere from 8-45 seconds); thus, many teachers have commented about how they do not interfere too much with the pacing of the lesson. Further, students get to see their teachers positioned as learners.

It is this exploratory nature of the classroom visits in the math lab model that makes the purpose and nature of time in classrooms distinct from other professional development models. For example, lesson study (Fernandez, 2002) has a classroom visit component as well. In lesson study, however, when teachers go into classrooms together, the observing teachers do not interject or take turns teaching the lesson. Typically, observing teachers have particular roles that involve circulating among students in order to take notes on various features of the enacted lesson. The purpose of a lesson study visit focuses on the execution of a carefully crafted lesson that has taken a considerable amount of time to research and design in order to consider whether lesson objectives were met, how students engaged and made sense of key ideas, and whether further refinements may be needed. Discussion about refinements happens after, not during, the enactment and is ultimately published for other teachers to use.

In contrast, classroom visits in math labs were intentionally designed to allow educators opportunities, in real time, to experiment with ambitious instruction. In effect, the team members collectively own the lesson they design, trying out different representations and pedagogical moves to elicit and respond to students' thinking. The lesson plan itself is more loose and flexible and planned in a comparatively short amount of time. All of the educators have the responsibility to enact the lesson together, through eliciting and collectively responding to student thinking. The classroom visit model allows teachers to interject at any time as the team co-engineers the enactment. Participants signal a TTO to ask a question of one another (e.g., "Should I ask *x* question next or *y*?" "Is this a good time to try to represent this students' ideas?"), to pose a question for the students (e.g., "Wait, let's ask students about . . ."), or to narrate their decision-making (e.g., "I think I'd like to pursue this mathematical idea next with students").

Conceptual Framework

Learning to teach in ways that elicit and respond to students' mathematical thinking and that centers on learning about the resources that children bring to the classroom from an asset-based perspective is not trivial. Because we are asking teachers to create conditions in their classrooms which they have not typically experienced themselves as students, much of the professional learning literature has repeatedly argued for designing experiences that deprivatize practice and that give teachers ample opportunities to create a new shared vision for this type of teaching practice (Kruse, Louis, & Bryk, 1995).

Educators learning together is important for the improvement of classroom practice. By practice, we mean the work that teachers do in the classroom to engage students in the forms of learning that are valued by the community. This view is in line with how Cook and Brown defined the term practice as "the coordinated activities of individuals and groups in doing their 'real work' as it is informed by a particular organizational or group context" (p. 386). Moreover, this view of practice includes the understanding that how one engages in teaching motivates, gives meaning, and shapes identities as particular kinds of teachers (see e.g., Lave & Wenger, 1991).

Professional communities can provide opportunities for educators to develop a common professional discourse that names important aspects of instructional practice and student learning, which is essential for productive discussions about teaching and learning (Ball & Cohen, 1999; Cobb, Zhao, & Dean 2009; Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Horn & Little, 2010; Kazemi & Hubbard, 2008). Such communities can provide support for teachers to take the risks necessary to reorganize their instructional practice, as well as result in a greater consistency in instruction and in opportunities for student learning (Horn & Little, 2010).

The literature on organizational improvement indicates that carefully designed organizational routines are an important means to support learning (Sherer & Spillane, 2011). These routines can embody what is valued in an organization. Feldman and Pentland (2003) defined organizational routines as a "repetitive, recognizable pattern of interdependent actions" (p. 311) that teams of people enact as they work together. In our analysis of TTO, we were concerned with understanding how TTO, which became an organizational routine at the school site, enabled teachers to work collectively on learning about teaching and to realize the community's goals of learning from and with students about their mathematical thinking.

Method

The primary purpose of the paper is to present an in-depth analysis of the TTO routine in order to examine the potential of the routine to support learning of educators and the formation of school-wide community. In this analysis, we use an illustrative case in order to examine how the routine opens up instructional practice in a collective learning environment for experimentation.

Participants and Case Selection

The school-based professional development was situated in an urban, high-needs school, Hilltop Elementary (all names are pseudonyms). The professional development implementation was the result of a three-year university-school partnership. The data for this analysis came from a larger data set collected across three years. The classroom visit we analyzed came from a math lab that occurred in the project's second year with a team that included nine participants: three fourth grade teachers, two fifth grade teachers, the school mathematics coach, the school principal, the ELL teacher, and the university mathematics educator acting as a co-facilitator (see Table 1).

This classroom visit was selected to examine the TTOs that were taken by the team, because the routine had already been established across the school. By this time, the routine was commonly used across all of the different math lab learning events that took place for each grade level across the school, as well as when the coach was in teachers' classrooms working with them one-on-one. By analyzing an episode after the routine was established, we could understand the routine's potential for supporting teacher learning and school-wide improvement. For a portion of the participants, this was the 11th math lab in which they had participated spanning across two school years. For teachers, who were new to the school in the fall, this was the fourth math lab they had attended. The principal and coach participated in all math labs; this was approximately their 36th math lab.

Table 1: Math Lab Participants

Participant	Role	Years in Current Role
Becky	Fourth grade teacher	2
Leslie	Fourth grade teacher	7
Soren	Fourth grade teacher	4
Amy	Fifth grade teacher	3
Saira	Fifth grade teacher	2
Kathleen	Building ELL teacher	3
Julie	Building principal	2
Tara	Building math coach	2
Elham	University facilitator	10

Data Sources

The classroom visit was videotaped and lasted 45 minutes. The TTO routine would not serve its purpose if it were not situated within broader aspects of the professional development model – including the collaborative planning, enactment, and debriefing cycle within the structure of math labs, as well as other school-wide activities and norms (e.g., a strong school-wide culture of professional learning and attending to students' experiences and thinking) (Gibbons, 2017; Gibbons, Kazemi, & Lewis, 2017). Although it is beyond the scope of this paper to account for all of the broader aspects that influenced the learning environment for teachers, we do attempt to situate the TTOs in the larger professional development context by examining: (a) field notes captured prior to the classroom visit to explore the groups' co-planning session, (b) field notes to examine the educators' collective reflection on the classroom visit after enactment, and (c) individual end-of-day written reflections about how TTO supported their thinking and learning. Two university researchers, the first and third authors, were present to collect data.

Data Analysis

Identifying TTO episodes. To generate a description of what constituted a TTO episode, we systematically reviewed the recording of the focal classroom visit to document instances where educators paused instruction. We identified a TTO as a time when instruction was paused so that educators could make sense of and/or act on student thinking, pedagogical decisions, and/or mathematical content. Using this description of TTOs, the four authors agreed that there were six TTO episodes in the selected case. For the sake of space, four TTO episodes will be reviewed in this analysis.

Coding TTO episodes. Like us, Little (2002) was concerned with how to understand the relations among teacher community, teacher development, and the improvement of practice. As a result of her examination of a teacher study group within a high school English department, Little offered a framework for analyzing how teachers' engagement with one another was related to improvement of their instructional practices. Although our context involved facilitators and elementary teachers, the framework proved useful in our analysis of how the TTO functioned as an organizational routine to support teacher development and professional community for school-wide improvement. The framework attends to the relations among three ways teaching practice is construed in learning opportunities: (a) how practice is represented in teacher interactions, (b) what orientations toward practice participants take, and (c) how norms of interaction around practice come to be organized. Taken together, these three analytic tasks enabled us to show how TTOs created an environment that was organized toward the improvement of practice. Each of the components are described separately in the following paragraphs.

Representations of practice. How does practice come to be known and shared in the public exchanges within TTOs? We attended to what Little (2002) called the face of practice (i.e., what parts of classroom teaching were made visible in TTOs) as well as its transparency (i.e., how completely and specifically teaching decisions became rendered in TTOs). Examining both the face and transparency of practice enabled us to make visible what aspects of instructional decision-making and moves were resources for teacher learning. Moreover, we examined how those decisions were characterized as "simple or complex, static or dynamic, certain or ambiguous" (p. 934).

Orientation toward practice. A second analytic task was to understand what stance teachers were developing toward practice and its improvement by engaging together in TTOs. We asked: (a) how teachers were organized to take up issues of practice, (b) whether the interactions among teachers opened up or closed down particular considerations of practice, and (c) what human and material resources were employed during classroom visits. Engaging these analytic questions enabled us to interpret how TTOs were contributing to a stance of collective learning and how those public interactions broadened participants' instructional decision-making in relation to students' thinking.

Norms of interaction. Our third analytic task was to unpack the norms that governed TTOs. This meant understanding the typical ways that teachers planned for and conducted classroom visits. We examined how TTOs were initiated and structured, what roles team members assumed within TTOs, what tones and interactional conventions were used during public exchanges, and how team members positioned themselves both physically and socially.

Additional coding. Given the difference between our context and Little's context, we also coded for emergent components or patterns that contributed to our understanding of how TTOs supported learning. We coded the character, tone, and substance of interactions in dialogue and participation. We also coded for how the routine supported leaders (i.e., school-based coaches, principals, and university facilitators) in their work to assist teachers. For each episode, all four authors came to consensus on the codes we assigned and wrote analytic memos to capture whether and how the TTO episode showed potential to support the learning of educators and foster the formation of school-wide community.

One note for the reader: what will likely not come through in this paper, through the use of transcription, is the ways this routine happens naturally and seamlessly. When people watch video of TTO, they are often surprised at how comfortable and undisruptive the routine seems. It is a challenge to portray the invigorative and fluidity of the routine in a written narrative.

Findings

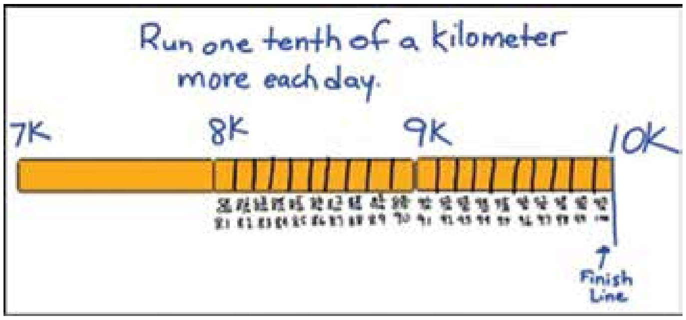
Before we examine the TTOs that were taken by teachers as they co-enacted instruction, it is important that we first situate the lesson enactment within the full math lab event. In the first section below, we examine the collaborative planning portion of the math lab cycle. We then present the four TTO episodes in chronological order. Using our analytic framework, we examine how particular components of practice were conveyed through interactions, how interactions created a stance toward practice, and how educators' participation was organized through each TTO. Finally, we present a cross-episode analysis, elaborating on the potential of the organizational routine to support collective learning and develop a professional community.

Context: Planning for the Classroom Visit During the Math Lab

The math lab analyzed here focused on how children relate decimal quantities and notations to already familiar fractional quantities. This math lab took place during a fifth-grade instructional unit that examined big mathematical ideas about fractions and decimals. Students had just begun work with decimals. The facilitators planned to focus on decimals during the math lab to support teachers' understanding of how to engage students with this content and to help uncover which conceptions of students about decimals were stable and which needed to be further supported.

For the day's classroom visits, the facilitator suggested leading the students in counting by tenths, first using fractional notation and then using decimal notation so that students could make connections between the two. This suggestion led the team to adapt an already familiar counting routine used across the school with the students (Turrou, Franke, & Johnson, 2017). The group decided to set the count in a linear context, counting by tenths from 8 to 10 in the context of training for a 10 kilometer run. They hypothesized that a linear context would support students in connecting the notations with the quantity. Further, students could consider how to partition a whole kilometer into ten equal-sized parts (see Figure 2). Using strips of papers to represent one kilometer, the facilitator could represent the tenths between eight kilometers and the finish line (10 kilometers). The team planned to coordinate this quantitative representation with written

FIGURE 2.
The count educators planned to enact with students.



(or symbolic) notation, so students could visualize the amount each number represented. Ultimately, the team was interested in how the counting activity could support students in coordinating their understanding of fractions with decimals.

The group nominated the university facilitator to initiate the instructional activity in the first classroom visit. At this point in our research-practice partnership, who led the lessons was more a matter of turn-taking. Typically, the teacher who hosts the visit is not the lead teacher (but can provide teaching support) because it is an opportunity to see their own students in a new way. Early on in the research-practice partnership, the university facilitator volunteered to lead lessons for a number of reasons: to model that it is okay to take risks with one's teaching, to demonstrate that no one is perfect or an expert, to develop trust in the group by initiating TTOs, and to show that listening to children's ideas is paramount to the classroom visit. In early enactments, she started the lesson as the lead teacher and the other educators (i.e., the teachers, principal, and coach) played an active role in enacting the lesson. The coach began to use the TTO routine as she worked one-on-one with teachers in their classrooms, changing the nature of her work with teachers to working together throughout the lesson to solving problems of practice together. As teachers and the principal became comfortable with the TTO routine, they volunteered to take the lead teacher role.

It is important to note that the whole team had to collaboratively plan the lesson and understand the mathematical aims and goals of the lesson. Before going into the classroom, the lead teacher rehearsed what she would say and received input from the team around how to launch the count. A central problem of practice, to which the team planned to respond, was how to work with students on understanding how to write the decimal number that comes after 8.9. They anticipated some students would write 8.10 to represent eight and ten-tenths and others would write it as 9.0. This conversation laid the groundwork for what the educators aimed to understand about students' thinking.

Focus Classroom Visit

Introduction to students. At 9:45 a.m., just a little over an hour after they began the math lab, the team walked into Amy's fifth-grade classroom. Amy invited the students to sit on the carpet at the front of the room and the team settled in among them. Many of the students had experienced classroom visits before and were accustomed to adults sitting among them during this time. The university facilitator explained the purpose for the educators' being in the classroom, setting the stage for both student learning and teacher learning.

> Lead Teacher (University Facilitator): Okay everybody, so all the teachers are here with me today because we want to see what you think about this problem. . . . Sometimes teachers think of things that they can try with kids, but they are not exactly sure how it's gonna go, and they might need to talk to each other. You know how we do Teacher Time Out? [Some children nod and others say 'yes'] Yeah, this might be a lesson where I am gonna need to do a Teacher Time Out. Or, other people are gonna say, "Wait, wait, wait, I have a great idea." If you hear other people jumping in, it's cool, it's because this is our work. We are getting to play.

In this interaction with the students, the lead teacher explained TTO in a manner that continued to normalize pausing instruction in order to engage in professional interactions. She spoke to the students and to the team in order to nurture the idea that it is okay for her to seek guidance and that anyone could try out an idea they wanted to pursue with the students. When the lead teacher said, "Sometimes teachers . . . are not exactly sure how [the lesson is] gonna go," she signaled that teaching is a complex practice, and therefore the experience is going to pull on the collective capacity of the educators who will try different instructional ideas or pedagogical moves. This move opened up inquiry into practice by inviting teachers to "jump in" to make critical considerations of teaching practice and underscored that to be inquisitive about how to support students' understanding is "our work."

Additionally, by saying, "We get to play," the lead teacher set the tone that this activity is exploratory and playful. Finally, by saying, "We want to see how you think about this problem," she positioned students as the teachers. Another common phrase often used with students, "You are our teachers," communicates to students that educators want to learn from their thinking.

Launching the problem. The lead teacher launched the problem about training for a race, explaining that her goal was to eventually run ten kilometers. She explained to students, "Right now I can only run eight kilometers comfortably. In my training . . . [I plan] to run one tenth more of a kilometer each time I run." She connected this problem context to the linear representation that Amy was creating by placing strips of paper up on the board (see Figure 2), and then she led a discussion about the size one tenth of a kilometer. After the group established that one-tenth is one part of a whole broken into ten equal-sized parts, the lead teacher explained that they would count altogether by one-tenths, starting at eight kilometers.

Students began counting and the lead teacher notated the count using fractional notation. With the accompanying fraction notation (see Figure 2), the lead teacher completed the count from eight to ten and then introduced the idea of writing the same quantities in decimal notation. After they established how to write eight and one-tenth as a decimal, they recited the count again from eight kilometers to ten kilometers. They recorded the count with decimal notation, the lead teacher intentionally allowing the students to use the more informal way of reading decimals (eight point one) hoping this would raise the focal issue for this lesson. Students said, "Eight point one, eight point two, eight point three." After they said, "Eight point nine," some mumbling and confusion followed. Some students said "eight point ten" (for eight and ten-tenths), while others protested that it should be "nine." The lead teacher asked the students to talk with a partner, "What should I write? Talk to your neighbor [about what I should write]."

When the lead teacher called the students back together, she elicited ideas from multiple students about whether they should write "8.10" or "9." One girl offered, "Nine in front of the decimal point means that it's a whole, and if the nine is . . . behind the decimal point, that means it's a tenth." As teachers had predicted in their co-planning prior to the classroom visit, this girl shared what she knew about how to read decimal notation by describing what happens to the value of the digit if placed before or after the decimal point.

Episode 1: How to tie back to fractions. Wanting to make a transition from the decimal notation to the fractional notation, the lead teacher called a TTO to signal to her team that she sought some input on how to do that. The one-minute exchange unfolded in the following way:

> Lead Teacher: Can I do a quick Teacher Time Out?
>
> Students respond: Yeah. [giggling]
>
> Lead Teacher: I am wondering how to tie back to the fraction?
>
> Julie (principal, who is sitting among the students) [to Lead Teacher]: Can I ask them a question?
>
> Lead Teacher: Yes!
>
> Julie: [to students] Can anyone explain your thinking about how you, using decimals, can show the ten-tenths part? That's where everybody went, "Ahhhh!"
>
> Lead Teacher: We got to 8 and ten-tenths.
>
> Julie: So, we got 8 and ten-tenths and then we heard all kinds of answers. Can you write ten-tenths, *ten-tenths* as a decimal? How do you write ten-tenths as a decimal?
>
> Students: [some students murmur, while some are unsure]
>
> Julie [to the lead teacher]: Should we do a turn and talk?
>
> Lead Teacher [to Julie for a quick clarification]: Is that the question you are asking?
>
> Julie [responding affirmatively and directing a question to students]: How do you write ten-tenths as a decimal?
>
> Lead Teacher [adding a question of her own to students]: What does ten-tenths equal?
>
> [Students then turn and talk to each other with teachers listening in]

As a result of this TTO, students heard two questions to discuss with a partner: how does one write ten-tenths as a decimal and what is it equal to? As students talked with one another, the teachers sitting among students on the rug *listened* carefully to their sense-making. This question was at the heart of what they were curious about students' thinking. In this first TTO episode, the lead teacher genuinely sought assistance with generating a question that would help students connect the two notation systems. At this critical junction, teaching was portrayed as a complex practice that was improved when the collective capacity was pooled to make decisions. Students responded to the TTO call with giggles and a permissive "yes." This conveyed the curious and playful tone that often accompanied the TTO exchanges.

These interactions were quick and telegraphic. Julie politely asked for permission to ask a question directly to the students, indicating the norm that anyone, including the principal, can jump in and help enact the lesson being developed. The lead teacher did not hesitate and responded enthusiastically, "Yes!" The TTO opened up instances of improvisation for other educators to help identify the right phrasing to support students' understanding.

These brief interactions demonstrated how the team made aspects of practice visible: teaching entails helping students make sense of certain ideas, and the team does not want to do the thinking for students. By noticing students' reactions to an earlier question – when they said, "Ahhh" – Julie suggested asking, "How do you write ten-tenths as a decimal?" The lead teacher confirmed Julie's question, saying to her, "Is that the question you are asking?" In the moment, the lead teacher rephrased the question asking, "What does ten-tenths equal?" Julie's question, "Should we do a turn and talk?" signaled to team members that this was a time in the lesson to listen closely to how all the students would attempt to answer the question, thus making further instructional decisions dependent on what teachers learn by listening.

Episode 2: How do you write T-E-N T-E-N-T-H-S? The second TTO episode, which lasted about 90 seconds, took place right after the students finished talking with their partners about the questions posed by Julie and the lead teacher. The lead teacher initiated a discussion about decimal notation.

> Lead Teacher: So, Damien, you had an idea about this? [Julie] said, you have something that might be good for us to hear.
>
> Julie: So my question to everybody was, how do you write ten-tenths as a decimal?
>
> Some students: Ooh! (raising hands)
>
> Lead teacher: And Damien had an idea?
>
> Julie: Damien had an idea.
>
> Saira (fifth grade teacher, who is sitting among students) [to teachers]: Teacher Time Out real quick. Teacher Time Out. Umm the connection, the piece around recording the fraction, the decimal number and the words, T-E-N-T-H-S. . . . Just to clarify Julie's question first . . . I know all the kids were seeing different things about what you were asking. So, to use the words T-E-N dash T-E-N-T-H-S. (Looks around at the teachers) Can I spell? *(teachers giggle with her).*

Saira paused the instruction to raise her concern about whether students were all hearing the spoken words in the same way, that is, whether students were hearing the "-ths" in ten-tenths (or instead hearing ten tens). While she was listening to the turn and talks, she observed that students had interpreted Julie's question in a few different ways, a clear benefit of having many teachers on the rug with students. Saira's quick TTO inserted the idea that writing the words *ten-tenths* on the board might support students' understanding of what was being said by the educators and other students. Continuing to contribute to the playful tone of these interactions, she too made the group laugh by poking fun at her ability to spell aloud.

This interaction showed how Saira made particular aspects of practice visible: supporting students' academic language and coordination of the verbal aspect with the symbolic aspect of number. From her place in the room, Saira listened during the students' turn and talks and heard some students thinking that they were answering a question about ten tens, not ten-tenths. By making her concern public to the team, Saira encouraged the group to pay attention to the role of oral and aural language, helping the group to consider the usefulness of writing out the verbal representation on the board as a public record of the mathematical work. Her use of the TTO emphasized that the team's role during the classroom visit is to listen to students' ideas and offer instructional moves that are responsive to those ideas.

After Saira stated her concern, Julie, who was at the front of the room holding the pen, stepped back into teaching mode. She attempted to address what she thought Saira had suggested.

> Julie [to students]: So, these are each how much? *(pointing to representation)* One tenth. And when she ran for ten days, she reached ten-tenths, which is how many kilometers? How many whole kilometers?

Students: One.

Julie: So ten *whats*? Ten-*tenths*—is that what you're getting at, Saira?

Leslie (fourth grade teacher, who is sitting among students) [to Julie]: I think she wants to see it written. The words. The letters.

Julie [to students]: Ten-tenths is how much she ran in those 10 days. And ten-tenths is written like this. *(Julie writes 'ten-tenths' on the board)*

When Saira voiced her concern, her colleagues worked to understand and enact her suggestion. Because TTO interjections can be brief and somewhat telegraphic, Julie checked with Saira to see if she had taken up her suggestion adequately. Julie's move to check with Saira allowed Leslie, who was listening carefully to make sense of Saira's suggestion, to articulate that Saira wanted to see ten-tenths written on the board. True to all TTO interactions, Saira was positioned by the team as a valuable member whose insights will help the team learn about orienting students to important mathematical ideas. This TTO involved three educators, which helped reinforce the norm that the team is enacting the lesson together.

Episode 3: Comparing 8.1 to 8.10. The lead teacher continued the lesson by resolving the problem of which number should come after 8.9 in the count. She asked students how to read 8.9. They agreed it is read, "eight and nine tenths." Remembering Saira's concern, she wrote out eight and nine tenths on the board. The lead teacher then said, "So after eight and nine tenths, the next number should be?" There was still some hesitation in the students' responses. One of the teachers, Leslie, called a TTO.

Leslie [to educators]: Can I Time Out now? To just ask the kids if they [can] make sense between this *(walks up to the board and puts a box around the 8.1 at the beginning of the count)* and that *(puts a box around the 8.10 at the end of the count)*

[Students begin excitedly to raise their hands and talk]

Leslie [to students with enthusiasm]: Turn and talk!

[The volume of talk spikes as students immediately start to share their ideas.]

Leslie noticed that students hesitated after the lead teacher asked what number should come after eight and nine tenths. The TTO allowed Leslie to improvise in the moment, offering an idea to orient students toward why it is problematic that 8.10 has been offered as one guess to what comes after 8.9. By walking to the board and using the pen to mark on the number line, Leslie reinforced that the lesson was being co-enacted. Leslie was curious if students would see that 8.1 is equivalent to 8.10, and therefore it is problematic to show up in two different locations on the number line. Through the TTO, Leslie made visible a particular line of questioning that might challenge students' ideas about notational system and the quantities represented. Sensing students' willingness to take up her question through many audible "Ohhhhs," the immediate increase in the volume of student talk confirmed Leslie's decision to direct them to turn and talk.

Later during the debrief, Leslie explained to the team why she asked students to make sense of 8.1 and 8.10 showing up in the count. She wondered why students did not recognize 8.10 despite their potential familiarity with decimal notation within the context of money:

Leslie [to educators during debrief]: I wondered why it was not obvious is this idea that eight point one zero is not the same thing as nine. It cannot be the same thing. . . Like if it was money, eight dollars and ten cents is not the same thing as nine dollars.

By later making public the rationale for her decision, she supported the team in understanding why asking about the two numbers might contribute to the discussion and students' understanding of decimal notation.

We continue the description of the lesson where it left off with Leslie's turn and talk comparing 8.1 to 8.10, as the lead teacher pulled the students back together. Leslie had resumed her seat among the students.

Lead Teacher: Okay, I am gonna do something here. Just to make sure we all agree and that we actually have established something. After we get to 8 and nine tenths, the next number that I reach is my 9 kilometers. Right? [Students agreeing by nodding or saying "yes."] . . . So we revised our thinking *(crosses out 8.10 in the count)*. We said that we would write it as nine because we got to eight and ten-tenths. So, is this correct? *(points to the nine, students nod in agreement)*. And is this correct? *(points to 8 10/10, students nod in agreement)*. And then if I write 8.1, that's where we started.

How do you read this number? (see Fig. 2)

Boy: Eight and one tenth.

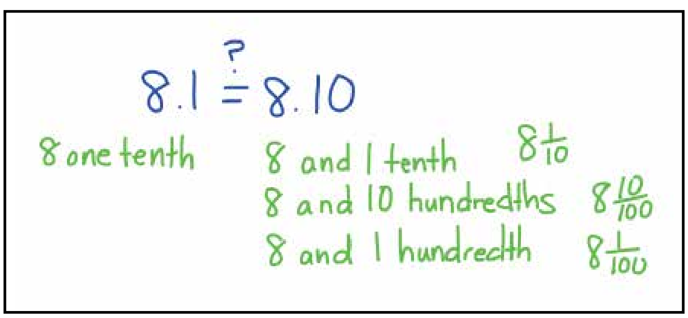
Lead Teacher: I am gonna write the words 'cause it's helpful (writes eight and one tenth). That's how we read that number. That's how we read that fraction. . . . People are comfortable with this (8.1) being 8 and one tenth, right? [Students agree]. For this one (8.10), I heard two things, eight and one tenth and I also heard eight and… [Boy: hundred] I thought I heard eight and ten hundredths.

The students continued to discuss how to translate 8.10 into the equivalent fractional notation and written words, and the lead teacher wrote their contributions (see Figure 3). The next episode of TTO immediately follows.

Episode 4: Are we moving into another lesson? This more extended TTO episode, lasting two minutes, involved the lead teacher and a fifth-grade teacher, who discussed whether the lesson was wandering from the original goals.

Lead Teacher [to educators]: Do you see where I am going? I am trying to see if they can translate the words back to the symbolic notation to help them think about which of these is the right way to read this number. (see Figure 3)

FIGURE 3.
Public record on white board comparing 8.1 and 8.10.



By pausing to check in with the team, she made her instructional decision making public. She highlighted opportunities to learn from what students were saying and doing, and how to make decisions in response to students' current thinking. Her new aim was to support students in connecting the decimal notation, both verbal and written notation, to fractional notation, using records of each on the board. One of the educators called a TTO to raise a question.

Saira [to the lead teacher]: Can I take a Teacher Time Out?

Lead Teacher [responding to Saira]: Yeah.

Saira: Taking a Teacher Time Out, teachers, to ask: are we moving into another lesson – right? Prior to extending the goal, the purpose and the objective before we go to this place – right? This looks like [a lesson for] another day.

The TTO allowed Saira to wonder aloud with her colleagues whether they had reached the day's goal and whether they were moving into another day's lesson. The discussion in this TTO portrayed high-quality teaching as requiring clear instructional goals, both long- and short-term goals that guide teaching over a unit and each lesson. The facilitators of the professional development intended for the classroom visits to not just be about teaching a lesson to students, but also about exploring students' current reasoning about a big mathematical idea through enacting particular instructional activities. For this reason, the lead teacher responded:

Lead Teacher: So, I think what's interesting is that when we count by fractions, we are pretty good at counting those by fractions. It feels pretty comfortable 'cause you are just counting the tenths and they know that once you get to ten-tenths, they [get to a] whole. So then you start over. But it's not clear what happens within this *(points to the board at 8.10*, see Fig. 3), and I am also thinking that because we learned to read things with 2 digits as hundredths, I am wondering if we see the equivalency [to the fraction notation] here.

Saira: That's helpful, thank you.

Lead Teacher: But I think this is the issue. We've learned something [about our students' understanding].

The lead teacher's response signaled that she believed students were comfortable counting by tenths. However, the new question was whether students understood that 8.1 and 8.10 are equivalent quantities. Furthermore, the lead teacher was curious if connecting the decimal notation to the fractional notation would support students in seeing that the two quantities are equivalent, while the third (eight and one-hundredth) is not.

In this TTO, educators were oriented toward the idea that teaching includes being students of their students. It is necessary to understand students' current reasoning in order to make important decisions about instruction they design for students. When the lead teacher said that the students appeared to be comfortable counting by tenths, she was assessing that they were able to reach the original goal. When the lead teacher said it was not clear that they could connect the quantity of eight and ten-tenths with its decimal notation, she was assessing what was confusing for students. Here, the lead teacher gave a good example of teaching being portrayed as something that can be adjusted in the moment based on assessment of student thinking.

Before continuing with the lesson, the lead teacher consulted with the other educators, asking if they had something to share, inviting others to participate and expose their own wonderings in relation to the lesson. Though no one responded, her question helped set the norm that educators were accountable for helping to co-enact the lesson, which required them to coordinate the goals set out in advance, consider students' reasoning that unfolded during the lesson, and consider potential instructional and pedagogical decisions to help move the instruction forward.

The lesson continued for another ten minutes. Students finished the count by decimals to ten. After tying the count back to the context (i.e., how many days it will take to reach her running goal), the lead teacher checked with the team to see if they agreed they had reached a good stopping point. The team then thanked the students for letting the educators learn from them and returned to the teachers' classroom to debrief.

Debrief Back in Teachers' Classroom

Back in the teachers' classroom, the educators gathered around the table to talk about what took place in Amy's fifth grade classroom. They had 30 minutes to reflect and revise the lesson before they taught the same lesson in Saira's fifth grade classroom. The lead teacher opened by saying:

> Lead Teacher (facilitator): That was really great. In the moment, we were able to co-problem solve together and really try to think about what's the math we're trying to get kids to think about and how we can support them. . . . Let's think about what we learned and what we want to try.

The discussion centered on how teachers were surprised that so many students did not reason that 8.10 is not the same as eight and ten-tenths. They hypothesized what to do differently in the second classroom visit.

Cross-Episode Analysis

Looking across the four episodes of TTO, we offer an analysis of how the TTO routine makes public the work of teaching, orients teachers to the complexity of practice, and structures participation towards improvement (see Table 2 for a brief description of each episode).

Table 2: Brief Summary of Four TTO Episodes

TTO Episode	Summary
Episode 1: How to Tie Back to Fractions	The lead teacher asked for assistance with how to support students' understanding of the decimal notation for the number following 8.9.
Episode 2: How do you write T-E-N T-E-N-T-H-S?	A fifth grade teacher raises concern about whether students were connecting the fraction and decimal notation with the verbal pronunciation of the numbers.
Episode 3: Comparing 8.1 to 8.10	A fourth grade teacher wanted to orient students toward a mathematical idea, considering whether 8.1 is equivalent to 8.10.
Episode 4: Are we moving into another lesson?	A fifth grade teacher asked whether the lesson was going away from the intended goals. The lead instructor makes her instructional decisions public to the team.

TTOs Make Public the Work of Teaching

We found that TTOs help make evident that teaching mathematics involves eliciting and responding to students' ideas in relation to mathematical goals. During the visit, educators worked together to enact instruction they had co-designed, elicit and respond to students' thinking, and revise their lesson in-the-moment based on students' understandings of the mathematics. We identified four significant components of practice on which educators worked publicly together: (a) the development of content goals, (b) the enactment and revision of content goals, (c) the creation of models of students' ideas, and (d) the facilitation of productive mathematical discussion.

Opportunities existed for educators to make sense of and alter instruction in the moment, based on students' understanding. In other words, there were opportunities to work collectively on practice in practice (Lampert, 2009). The TTO gave the team access to each other's decision making in the context of responding to students' thinking. Educators had opportunities to formulate questions, to modify or add to representations of student thinking, and to structure discourse opportunities that they believed would support students. For example, the principal described a particular aspect of practice that was highlighted in TTO Episode 3, how teachers can use markings (e.g., boxes around numbers) to call students' attention to the recording on the board.

> Julie (during the end-of-day reflection): I got to see the modeling by a whole bunch of people. Like when you [points to Leslie] boxed the numbers in with different colors . . . [and asked] can those both be the same . . . Saira and I were both like, "Oh" . . . I didn't think to represent it that way. But when you highlighted it like that, I was like, "Oh, that's a really good idea."

Because they could work on practice in the moment, with students present, the team was able to deepen their understanding of high-quality mathematics teaching. For example, one teacher reflected that the teacher's role is to "adjust and revise . . . based on what [students] need." It is complex to adjust and revise in the moment – to do so effectively takes the ability to uncover students' current ideas and assess these ideas against student learning trajectories and the goals for their learning. We saw the team work on this together in TTO Episode 4 when the lead teacher explained why she had moved to asking students to name the number 8.10.

The nature of classroom visits and the routine of TTO render parts of practice more visible to the team than if the team had observed only one person demonstrating or modeling a lesson. Furthermore, the TTO allows the course of the lesson to be altered or changed. Making alterations in the moment can allow for richer learning opportunities for students and educators.

TTOs Orient Educators Toward the Complexity of Practice and a Collective Stance Toward Its Improvement

The TTO routine helps to portray improvement in teaching as working to address and learn from problems of practice. The university facilitator highlighted how the orientation toward improving practice has evolved:

> Lead Teacher (during the end-of-day reflection): Earlier [in our work together] there was a trepidation in stepping in on others' teaching. Now we want help from each other. It's not about embarrassment, it is about supporting each other, an opening to try things with kids . . . work[ing] on the craft of teaching together.

The routine supports the notion that all educators, no matter their role or title, are working on learning and improving together. This was evident when the school-based coach said, "Even [the university educator] gets to learn alongside us, too."

Teachers referred to TTOs as becoming a "shared think space" and a time to "step aside, think aloud, and join in thinking time with others." Furthermore, many teachers commented on how the routine helps them when they are by themselves in their own classrooms. One teacher said, "In the midst of my classroom, I'm giving myself permission to take a TTO [and ask] what would Leslie do here? What would [the university educator] do here?" Engaging in deliberate practice in the company of the team, allows individual teachers to refine a system for knowing when, why, and how to respond to problems of practice (Lampert et al., 2013). Even when they are alone in their classrooms, the structure of TTO provides an opportunity to adapt and innovate in situations of uncertainty through recalling the expertise of others.

The routine demonstrates that part of the work of educators is to help each other collaboratively solve problems of practice in and beyond professional development days. Nearly all of the teachers at Hilltop remarked that all of the adults in the school community are learners. The routine creates a social setting where educators can develop a shared vision, common purpose, and commitment to teach ambitiously.

TTOs Structure Participation

Resources for teachers' development are created in and through interaction, as teachers talk with one another and work together on practice (Little, 2002). In this section, we consider how TTOs helped structure teachers' participation and interactions with one another.

Collaborative planning, enactment, and debriefing. Highly influential in structuring teachers' participation and interaction was the collaborative planning, enactment, and debriefing of the lesson. Prior to the classroom visit, the team co-planned the lesson. As participants planned their work with students, they attended to a wide variety of aspects of planning for instruction, such as identifying big mathematical ideas, selecting a task, discussing means of mathematical representations, and considering how to support students' learning of key mathematical ideas. Entering the classroom with the lesson co-planned established the sense that the team co-owned both the lesson and the enactment. Therefore, it became normal and expected that team members would jump in to help enact and adjust the lesson in the moment. The process of engaging in the co-planning, along with having a shared focus on students' thinking, framed the work of the team to focus on what students were doing and to co-problem solve what should happen next in the lesson. Finally, there were times for formal debriefing about what they had learned about students' current understandings and their work to support student learning. Members of the team could choose to bring up observations in the moment in order to steer the lesson in particular ways, or they could wait until the debriefing conversation to bring up certain decisions or observations. Several team members narrated the impact of the planning and debriefing, remarking that going into the visit with shared questions shaped the way they "experimented as a group" and that the debrief was "effective because [they shared] a common experience."

The importance of classroom visits. Classroom visits provided open opportunities for assessing students' current understandings in order to plan for future instruction. When asked to reflect, one teacher described classroom visits as being "a hunt" to comprehend students' thinking and respond to those understandings in the moment, as well as later when planning for future instruction.

> Leslie (during the end-of-day reflection): Today it just felt like a hunt. That we knew that there was some place along the line where [the students] fell off the rails with decimals and we were looking for that spot. Where is it that they're like, "Oh yeah, that makes sense, that makes sense" and then, "Huh"? And it's like OH YEAH! THERE IT IS! That's the spot. So then all of us had a few questions about what do you think about this? And what do you think about that? And my thought was, okay you've got 8.1 here and 8.10 here, how can that be? And asking them to explain that distance and how can that be. Asking them to reason their way through it. And it just became so obvious, where the cluster of confusion was, that now we know what to work on.

TTOs gave the team opportunities to make sense of student reasoning and think through instructional decisions as the lesson unfolded.

Physical arrangement during classroom visits. With the purpose of eliciting, understanding, and responding to student thinking in mind, the team sat with and among the students on the floor during the classroom visits. Being side-by-side with students enabled team members to listen to students' thinking and be ready to take up students' ideas. For example, in Episode 2, because Saira was sitting among students, she assessed that some students needed to see the words *ten-tenths* written on the board.

Team members were also in close proximity to one another. They talked aloud as a group, freely and, as teachers put it, "fluidly." It was also typical for team members to turn to one another, whispering about a particular idea. As one teacher described, "I was right next to Saira and we were able to process together. This gave me the opportunity to say aloud what I was thinking, get feedback [from her], and adjust before I decided to share with the whole group."

Reasons to call a TTO. Participation and interactions were structured through the various ways and purposes for calling a TTO. One way included using TTO to pause the lesson and make suggestions to the group for consideration (e.g., Episode 2, writing *ten-tenths* on the board). The math coach described these moments as, "Like having two conversations going on at once – one [is] the kids making sense of the decimals and the other [is] the teachers having a conversation side by side of them." Another purpose included using a TTO to press teachers to explain their decisions (e.g., Episode 4). One teacher described this purpose of TTO as allowing her to be "pulled into the angle to see where the other teachers were coming from."

These moments often resulted in substantive conversations among the team.

Other ways teachers took TTOs included when team members jumped in to ask students a question, took the lead teacher position, modeled the mathematical idea being discussed (e.g., Episode 3), or suggested a quick directive (such as "use a different color" or "let's do a turn and talk"). The smaller interjections were often elaborated on in debriefing conversations, so that all involved could understand why the suggestion was made. These smaller interjections were made possible over time because of the strong professional relationships and norms that joint work was being performed.

TTO atmosphere. As recorded in our larger corpus of data, we often heard from educators that TTOs are "invigorating" and an "affective experience," a routine that is both respectful and playful. This atmosphere helps create an environment where educators are willing and motivated to take the risks entailed by complex intellectual performance, such as teaching. Furthermore, TTOs enliven the classroom as a dynamic setting, not a sacred space owned solely by the teacher of record.

TTOs Support Multiple Role Groups

In the context of the classroom visits, there was no separation between what teachers and school leaders were doing. Instead, everyone was brought together for non-evaluative and substantive engagement around improving practice. We have purposefully used the terms *educator* or *team* to indicate that all involved, across the multiple role groups, were engaging in learning about the teaching and learning of mathematics. Particularly interesting is the way that TTO supported the work of the school-based mathematics coach, principal, and university facilitators in their unique roles of supporting teachers' learning.

For example, the school-based coach explained that she uses the TTO routine during classroom coaching visits in teacher's classrooms. During these visits, TTO allows the coach and teacher to collaboratively work on practice in the moment, providing individualized support for teachers to learn in and through practice. This routine pushes against some of the prevailing norms of coaching practices, where a coach observes and takes notes during the lesson and discussion about instruction happens after the lesson enactment. Another important role the TTO interactions play is to help inform the coach where teachers are in developing ambitious practices (Gibbons & Cobb, 2016). In a separate interview, the mathematics coach remarked that in the TTO conversations she is able to "notice what teachers are paying attention to," which helps inform her decisions about how to support the needs of individuals or groups of teachers.

The TTO routine allowed for the principal to engage with teachers as a learner. She did not just observe teachers at work, but participated as a teacher in order to understand more deeply with what teachers are grappling (see also Gibbons, Kazemi, & Fox, 2017). Participating in these ways allowed her to gauge what teachers were learning, in order to decide how and for what to hold teachers accountable in taking up new instructional practices as well as make decisions about what meaningful support they might need from the instructional coach. We have seen this form of participation by the principal to be an integral part of organizing the school for teacher learning.

University facilitators (mathematics educators) also benefited from the routine. We saw that TTO pooled the collective expertise of all types of educators, interrupting the idea that the university facilitators and coaches were the primary source of expertise. Instead, all educators were positioned both as experts and learners. This relieved a burden for teacher educators who are often guests in others' classrooms and do not know the students as well as the classroom teacher. However, it also raises new demands for a facilitator to learn how to take up and navigate collective inquiry, as the lesson should be co-engineered and steered by all. Future research is needed to understand the range of learning opportunities and demands for a teacher educator during TTOs.

The final role group to which we call attention is the elementary students. The educators physically sit among the students, whose ideas are at the center of the team's collective inquiry. During TTOs, students are positioned as teachers and their contribution to the team's learning is explicitly named. For example, at the end of the focal lesson, as the university facilitator talked with the team and the students about their lesson, she thanked the students, saying, "[We] really appreciate your helping us today." The principal added, "Thank you for this opportunity. We couldn't have stayed together as adults and learn what we learned without you." Through TTOs, students become more conscious of the role they play in the learning equation and see that their thinking matters to educators.

Conclusion

In this analysis, we examined how a routine, the *Teacher Time Out*, helped provide educators opportunities to collaborate with one another around teaching mathematics in authentic classroom-based settings with students present. Our investigation showed that the routine of TTO shaped the learning opportunities available to educators. Within the context of math labs, educators gained opportunities to co-plan lessons, anticipate students' thinking, and investigate various aspects of content and pedagogy. In the classroom visits, educators experienced opportunities to simultaneously enact, reflect on, and learn about practice in real time.

TTO interactions run counter to norms of privacy and evaluation more typical in US schools, norms which may inhibit opportunities to learn in and from practice together. The routine of TTO allowed teachers to move beyond talking about the work of teaching to actually engaging in collaborative sense-making of student thinking; it allowed them an authentic context in which to work on multiple aspects of practice in real time. This routine contributes to the literature on professional development by illuminating what Grossman and colleagues call a *pedagogy of enactment* (Grossman et al., 2009). The routine gives opportunities for teachers to develop actual questions to ask students, try them out, and then in-the-moment consider follow-up questions—not simply to discuss what they might do or discuss what they could have done. We hypothesize that the routine supports the complex endeavor of teaching mathematics, in that it supports teachers' ability to be adept at moment-to-moment decision-making to engage students in rich discussions (O'Connor & Snow, in press). Further, we hypothesize that the routine supported teachers to cultivate learning environments where everyone was positioned as capable of doing substantive mathematics and where teachers became skilled at drawing on students' multiple knowledge bases (Aguirre et al., 2013; Turner et al., 2012).

This analysis helped to characterize the routine and analyze its potential for supporting teachers' collective learning and development. Future research should seek to understand how the routine gets established with groups of teachers, including documenting productive norms used to support the introduction and maintenance of the routine. There is a need to understand how one enculturates the norms, including having members of the administration as part of the routine. Research will also seek to understand how facilitators develop the expertise to use the routine, including understanding how they draw on their goals for teachers' learning to make decisions about when or how to call a TTO. The authors have begun to use the routine in their work supporting preservice teachers. How can TTOs support the learning of novice teachers? How can the use of TTOs position teaching as an activity that is engaged in with one's colleagues, where novice teachers would be better situated to develop their instructional skills with colleagues as they begin their careers?

In the meantime, we believe our findings have shown that this routine, when engaged in a productive way, has the potential to support teacher development and the formation of professional learning communities. It shows respect for students and positions them as central to teacher learning. For school leaders who are interested in adopting the TTO routine in their work with teachers, along with our colleagues we have developed a set of tools available on a website, tedd.org, out of the University of Washington. The tools include: a facilitator plan for introducing TTO, a TTO handout for teachers, videos about TTO, a list of sample norms for TTO, a protocol for the classroom visit, suggestions for how to introduce TTO to students, and a guide for debriefing the TTO after enacting them in a classroom visit.

The current literature offers limited guidance about how educators can engage in learning opportunities in the presence of their students. While there remains much to discover about the routine and pedagogy of TTO, we believe it to have potential to support educators' learning and the development of school-wide inquiry communities. ✪

The work reported here was supported by the Spencer Foundation. Correspondence concerning this article should be addressed to Lynsey Gibbons, Boston University, 2 Silber Way, Boston, MA 02445. Email: lgibbons@bu.edu.

References

Aguirre, J., Mayfield-Ingram, K., & Martin, D. (2013). *The impact of identity in K-8 mathematics: Rethinking equity-based practices.* Reston, VA: National Council of Teachers of Mathematics.

Ball, D. L. & Cohen, D. K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In L. Darling-Hammond & G. Sykes (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 3-32). San Francisco, CA: Jossey-Bass.

Cobb, P., Zhao, Q., & Dean, C. (2009). Conducting design experiments to support teachers' learning: A reflection from the field. *The Journal of the Learning Sciences, 18*, 165-199.

Common Core State Standards Initiative. (2010). *Common core state standards for mathematics.* Washington DC: National Governors Association Center for Best Practices and the Council of Chief State School Officers.

Cook, J., & Brown, J. S. (1999). Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing. *Organization Science, 10*, 381-400.

Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). *Professional learning in the learning profession: A status report on teacher development in the United States and abroad*. Dallas, TX: National Staff Development Council.

Feldman, M. S., & Pentland, B. T. (2003). Reconceptualizing organizational routines as a source of flexibility and change. *Administrative Science Quarterly, 48*, 94–118.

Fernandez, C. (2002). Learning from Japanese approaches to professional development: The case of lesson study. *Journal of Teacher Education, 53*, 393-405.

Franke, M. L., Kazemi, E., & Battey, D. (2007). Mathematics teaching and classroom practice. In F. K. Lester, Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 225-256). Greenwich, CT: Information Age Publishers.

Gibbons, L. K. (2017). Examining mathematics coaching practices that help develop school-wide professional learning. In M. M. McGatha & N. R. Rigelman (Eds.), *Elementary mathematics specialists* (pp. 167-182). Charlotte, NC: Association of Mathematics Teacher Educators.

Gibbons, L. K. & Cobb, P. A. (2016). Examining content-focused coaching knowledge and practices implicated in designing coaching activities. *Elementary School Journal, 117*, 237-259.

Gibbons, L. K., Kazemi, E., & Fox, A. (2017, April). *Principal leadership practices that promote teacher learning in school-wide reform.* Paper presentation at the annual conference of the American Educational Research Association, San Antonio, TX.

Gibbons, L. K., Kazemi, E., & Lewis, R. (2017). Developing collective capacity to improve mathematics instruction: Coaching as a lever for school-wide improvement. *Journal of Mathematical Behavior, 46*, 231–250.

Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record, 111*, 2055-2100.

Horn, I. S., & Little, J. W. (2010). Attending to problems of practice: Routines and resources for professional learning in teachers' workplace interactions. *American Educational Research Journal, 47*, 181-217.

Kazemi, E., & Hubbard, A. (2008). New directions for the design and study of professional development: Attending to the coevolution of teachers' participation across contexts. *Journal of Teacher Education, 59*, 428-441.

Kazemi, E., & Stipek, D. (2001). Promoting conceptual thinking in four upper-elementary mathematics classrooms. *The Elementary School Journal, 102*, 59-80.

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.) (2001). *Adding it up: Helping children learn mathematics.* Washington, DC: National Academy Press.

Kruse, S. D., Louis, K. S., & Bryk, A. S. (1995). An emerging framework for analyzing school-based professional community. In K. S. Louis & S. D. Kruse (Eds.), *Professionalism and community: Perspectives on reforming urban schools* (pp. 23–42). Thousand Oaks, CA: Corwin.

Lampert, M. (2009). Learning teaching in, from, and for practice: What do we mean? *Journal of Teacher Education, 61*(1-2), 21-34.

Lampert, M., Beasley, H., Ghousseini, H., Kazemi, E., & Franke, M. (2010). Using designed instructional activities to enable novices to manage ambitious mathematics teaching. In M. K. Stein & L. Kucan (Eds.) *Instructional explanations in the disciplines* (pp. 129-141). New York, NY: Springer.

Lampert, M., Franke, M. L., Kazemi, E., Ghousseini, H., Turrou, A. C., Beasley, H., . . . Crowe, K. (2013). Keeping it complex: Using rehearsals to support novice teacher learning of ambitious teaching. *Journal of Teacher Education, 64*, 226-243.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge: Cambridge University Press.

Little, J. W. (2002). Professional community and the problem of high school reform. *International Journal of Educational Research, 37*, 693-714.

Martin, D. (2009). Researching race in mathematics education. *Teachers College Record, 111*, 295-338

National Council of Teachers of Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author.

O'Connor, C., & Snow, C. (in press). Classroom discourse: What do we need to know for research and for practice? In M. Schober, A. Britt, & D. Rapp (Eds), *The Routledge handbook of discourse processes* (2nd ed.).

Sherer, J. Z., & Spillane, J. P. (2011). Constancy and change in work practice in schools: The role of organizational routines. *Teachers College Record, 113*, 611-657.

Silver, E. A., & Smith, M. S. (1996). Building discourse communities in mathematics classrooms: A worthwhile but challenging journey. In P. C. Elliot & M. J. Kenney (Eds.) *Communication in mathematics, K–12 and beyond* (pp. 20-28). Reston, VA: National Council of Teachers of Mathematics.

Stein, M. K., Grover, B. W., & Henningsen, M. (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classrooms. *American Educational Research Journal, 33*, 455-488.

Turner, E. E., Drake, C., Roth McDuffie, A., Aguirre, J., Bartell, T. G., & Foote, M. Q. (2012). Promoting equity in mathematics teacher preparation: A framework for advancing teacher learning of children's multiple mathematics knowledge bases. *Journal of Mathematics Teacher Education, 15*, 67-82.

Turrou, A., Franke, M., & Johnson, N. (2017). Choral counting. *Teaching Children Mathematics, 24*, 129-135.

U.S. Department of Education. (2008). *The final report of the National Mathematics Advisory Panel.* Washington, DC: Author.

JOURNAL OF MATHEMATICS EDUCATION LEADERSHIP

Information for Reviewers*

1. Manuscripts should be consistent with NCSM mission.

   The National Council of Supervisors of Mathematics (NCSM) is a mathematics leadership organization for educational leaders that provides professional learning opportunities necessary to support and sustain improved student achievement.

2. Manuscripts should be consistent with the purpose of the journal.

   The purpose of the NCSM Journal of Mathematics Education Leadership is to advance the mission and vision of the National Council of Supervisors of Mathematics by:

   - Strengthening mathematics education leadership through the dissemination of knowledge related to research, issues, trends, programs, policy, and practice in mathematics education;
   - Fostering inquiry into key challenges of mathematics education leadership;
   - Raising awareness about key challenges of mathematics education leadership, in order to influence research, programs, policy, and practice; and
   - Engaging the attention and support of other education stakeholders, and business and government, in order to broaden as well as strengthen mathematics education leadership.

3. Manuscripts should fit the categories defining the design of the journal.

   - Key topics in leadership and leadership development
   - Case studies of mathematics education leadership work in schools and districts or at the state level and the lessons learned from this work
   - Reflections on what it means to be a mathematics education leader and what it means to strengthen one's leadership practice
   - Research reports with implications for mathematics education leaders
   - Professional development efforts including how these efforts are situated in the larger context of professional development and implications for leadership practice
   - Brief commentaries on critical issues in mathematics education
   - Brief reviews of books that would be of interest to mathematics education leaders

4. Manuscripts should be consistent with the NCTM Principles and Standards and should be relevant to NCSM members. In particular, manuscripts should make clear to mathematics leaders the implications of its content for their leadership practice.

5. Manuscripts are reviewed by at least two volunteer reviewers and a member of the editorial panel. Reviewers are chosen on the basis of the expertise related to the content of the manuscript and are asked to evaluate the merits of the manuscripts according to the guidelines listed above in order to make one of the following recommendations:

   a. Ready to publish with either no changes or minor editing changes.

   b. Consider publishing with recommended revisions.

   c. Do not consider publishing.

6. Reviewers are expected to prepare a written analysis and commentary regarding the specific strengths and limitations of the manuscript and its content. The review should be aligned with the recommendation made to the editor with regard to publication and should be written with the understanding that it will be used to provide the author(s) of the manuscript with feedback. The more explicit, detailed, and constructive a reviewer's comments, the more helpful the review will be to both the editor and the author(s).

* Please contact the journal editor if you are interested in becoming a reviewer for the *Journal*.

LEADERSHIP IN MATHEMATICS EDUCATION
NCSM NETWORK COMMUNICATE SUPPORT MOTIVATE

Membership Application/Order Form

Use this form to renew a membership, join NCSM, update information, or order items. Complete this form and return with payment. The information you provide will be used by the NCSM office for member communication, mailing lists, and the NCSM Membership Directory. Membership Dues are currently $85.

NCSM sometimes provides its mailing list to outside companies. These companies have been approved by NCSM to send catalogs, publications, announcements, ads, gifts, etc. Check here to remove your name from mailing lists. In addition, by checking this box, only your name without contact information will be included in the NCSM Directory. ☐

PLEASE PRINT LEGIBLY OR TYPE

First Name________________________________Middle _________

Last Name ____

Employer____

This is my complete address: ☐ Home ☐ Work

Title ____

Address ____

Telephone ____

Please check all that apply. I currently work as: (Optional)

- ☐ State/Provincial Department of Education Employee
- ☐ Government Agency (NSF, DOE, etc.)
- ☐ Member of Local Board of Education
- ☐ Superintendent
- ☐ District Mathematics Supervisor/Leader
- ☐ Principal
- ☐ Department Chair
- ☐ Grade-Level Leader
- ☐ Teacher Leader
- ☐ Author
- ☐ Coach/Mentor
- ☐ Consultant
- ☐ Curriculum Leader/Specialist
- ☐ Education Technology Provider
- ☐ Pre-Service Educator
- ☐ Professional Developer
- ☐ Publisher
- ☐ Teacher
- ☐ Other______________________________

Please check all that apply. I am a leader in mathematics education at the following levels:

- ☐ National
- ☐ Regional (more than one state/province)
- ☐ State/Province
- ☐ District/County/City
- ☐ Building
- ☐ University/College
- ☐ Senior High School
- ☐ Junior High/Middle School
- ☐ Elementary School
- ☐ Pre-Kindergarten
- ☐ Other______________________________

Since designations vary over time, check the one you feel best describes you:

- ☐ African American/Black
- ☐ Native American
- ☐ Asian American
- ☐ Pacific Islander
- ☐ European American/White
- ☐ Bi-Racial/Multi-Racial
- ☐ Mexican American/Hispanic/Latino
- ☐ Other______________________________

Check the area you serve: ☐ Rural ☐ Suburban ☐ Urban

Do you influence purchasing decisions? ☐ Yes ☐ No

Age: ☐ under 25 ☐ 25 - 34 ☐ 35 - 44 ☐ 45 - 54 ☐ 55-64 ☐ over 64

Work Experience:

- ☐ First year in position
- ☐ 2-5 years in position
- ☐ 8-10 years in position
- ☐ 11-20 years in position
- ☐ 21-30 years in position
- ☐ over 30 years in position
- ☐ retired

Please check all that apply. Which of the following characterize the community you serve?

- ☐ High percent poverty
- ☐ High percent of English language learners
- ☐ Racial and ethnic diversity
- ☐ None of the above

Qty.	Item*	Member	Non-Member	P&H**	Sub-Total
____	**Monograph: Future Basics: Developing Numerical Power**	$15	N/A	N/A	________
	PRIME Leadership Framework				
____	1-4 copies (each)	$16	$18	$4.95	________
____	5-9 copies (each)	$15	$17	$10.70	________
____	10-15 copies (each)	$14	$16	$14.50	________
____	16-99 copies (each)	$13	$15	**	________
____	100 or more (each)	$12	$14	**	________
____	NCSM Member Pin	$2			$________
			Merchandise Total:		$________
	Membership Dues	**$85**			$________
			Total order:		$________

***Availability of products and prices are subject to change without notice.**
****Postage/Handling**: Books are sent by USPS. For orders of 16 or more copies, contact NCSM Member & Conference Services for a postage and handling price. Outside the U.S. or for expedited orders, call for shipping prices.

Please return this form to:
NCSM Member and Conference Services
6000 E. Evans Avenue 3-205, Denver, CO 80222
Phone: 303.758.9611; Fax: 303.758.9616
Email: office@ncsmonline.org Web: mathedleadership.org

Payment Method: ☐ Visa ☐ MasterCard ☐ Discover Card ☐ Check/M.O. *(U.S Funds only)* ☐ P.O.**

Purchase Order # ______________________________________

Credit Card # ____

Cardholder Name______________________________ Exp ____/____

Cardholder Signature ___________________________________

Purchase orders will be accepted for PRIME orders only. A purchase order number must be included. ***Please note:* an invoice will NOT be sent. Should you need an invoice, please use this order form.

Emeritus Membership: Please check the NCSM website (mathedleadership.org) for eligibility requirements.

National Council of Supervisors of Mathematics
PO Box 3406
Englewood, CO 80155

Presorted Standard
U.S. Postage
PAID
Brockton, MA
Permit No. 301

LEADERSHIP IN MATHEMATICS EDUCATION

NCSM

NETWORK
COMMUNICATE
SUPPORT
MOTIVATE