From Book Club to Professional Learning Community: Empowering a Network of Mathematics Specialists

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Abstract: This article chronicles the journey of a group of mathematics specialists from regional K12 school divisions participating in a university-facilitated professional development. In response to the expressed needs of individual mathematics specialists, the authors designed a professional development framework based on effective teaching practices published by the National Council of Teachers of Mathematics (NCTM, 2014). Monthly meetings became the vehicle for the emergence of a professional learning community (PLC) centered on the shared construction of professional knowledge for school and university participants. University-facilitated PLCs can foster collective learning and action that responds to individual contexts and advances collaborative leadership practice across schools.

KEYWORDS: mathematics specialists, professional learning communities, university facilitated professional development, mathematics education, teacher leadership

NAPDS NINE ESSENTIALS ADDRESSED:
3. Ongoing and reciprocal professional development for all participants guided by need.
4. A shared commitment to innovative and reflective practice by all participants.
7. A structure that allows all participants a forum for ongoing governance, reflection, and collaboration.

Individuals are often "anointed and/or appointed" to mathematics specialist positions at both the building and district levels without the requisite "content, pedagogical, and leadership knowledge and skills" (Fennell, 2017, p. 9). They work in isolation to design instruction, support teachers, and build leadership expertise to enact and sustain meaningful change. Mathematics specialists may be challenged to find time away from their role as supporters of teachers, students, and schools-at-large to engage in the professional learning required to advance their knowledge and practice (Chval, Arbaugh, Lannin, van Garderen, Cummings, Estapa, & Huey, 2010). Continuing professional development contributes to mathematics specialists' evolving identities as they purposefully reflect on their practice to make instructional shifts within their schools. However, professional development opportunities for the mathematics specialists are typically limited to state conferences with coaching strands, graduate programs that lead to state endorsements, and division-specific professional development. Because mathematics specialists often do not have a group of peers with similar roles and responsibilities within their schools, they lack opportunities for sustained collaboration that is tailored to their unique needs.

The purpose of this article is to share how a university-facilitated professional development not only specifically targeted the learning needs of the participating mathematics specialists, but also provided opportunities for regular peer collaboration across a variety of school contexts and settings. The monthly mentoring experiences naturally became a forum which exhibited Hord's (2004) five dimensions of a professional learning community (PLC): 1) supportive and shared leadership; 2) shared values and vision; 3) collective learning and the application of that learning; 4) shared practice; and 5) supportive conditions for the maintenance of the learning community (p. 7). We use this theoretical framework to examine the organizational conditions, cultures, and structures that empowered our mathematics specialists to create and share knowledge within and across their schools. Through participation in this novel school-university PLC, university facilitators and school-based mathematics specialists alike gained broader perspectives on leadership in mathematics education.

Defining Mathematics Specialists

The joint position of the Association of Mathematics Teacher Educators (AMTE), the Association of State Supervisors of Mathematics (ASSM), the National Council of Supervisors of Mathematics (NCSM), and the National Council of Teachers of Mathematics (NCTM) defines elementary mathematics specialists as "teacher leaders who are responsible for supporting effective PK–6 mathematics instruction and student learning" (AMTE, ASSM, NCSM, & NCTM, 2013). They provide content and pedagogical expertise within their schools as classroom teachers, resource teachers, and coaches. The Virginia Mathematics and Science Coalition (2016) describes mathematics specialists as individuals in elementary and middle schools who "are released from full-time classroom responsibilities so that they can support the professional growth of their colleagues, promoting enhanced mathematics instruction and student learning throughout their schools."

We synthesized these definitions and use the term *mathematics specialist* to capture the broader roles and responsibilities of the participants in our study. Each participant served as a mathematics teacher leader within her community to promote instructional shifts in teachers'

practice and to advocate for rigorous and coherent opportunities to learn. Additionally, each supported K-12 mathematics students and teachers in a variety of roles at the classroom, school, and division level.

Background Literature

The prevalence of instructional coaching has increased significantly in the era of standards-based reform with the staffing rate of coaches doubling over the past 15 years (Domina, Lewis, Agarwal, & Hanselman, 2015). The recent publication NCTM *Principles to Actions: Ensuring Mathematical Success for All* (2014) acknowledges the critical role of mathematics specialists in enhancing teacher capacity, positively influencing teacher beliefs, and increasing teacher investment in professional development. While *PtA* specifically defines eight Mathematics Teaching Practices and calls on mathematics specialists to support implementation, an analogous set of high-leverage coaching practices is not provided. Although many resources are available on mathematics coaching strategies and structures, specific research-based coaching practices that both support teacher change and promote student learning are still being explored (Baker, Bailey, Larsen, & Galanti, 2017; Gibbons & Cobb, 2012). The lack of highleverage coaching practices highlights the complexity of the roles and responsibilities of mathematics specialists and the need for sustained support to meet the challenges of enacting *PtA* within their specific contexts.

Mathematics specialists often work in one or more capacities: data coach, resource provider, mentor, curriculum or instructional specialist, classroom supporter, learning facilitator, school leader, catalyst for change, and learner (Killion, 2009). In each of these capacities, they enact an additional layer of practice in leadership as they collaborate with school stakeholders and promote growth in classroom teaching (Fennell, 2006). However, the expertise demanded of mathematics specialists as they establish successful relationships with the teachers in their schools is broad; they must build interpersonal skills, content knowledge, pedagogical knowledge, knowledge of the curriculum, and awareness of coaching resources (Feger, Woleck, & Hickman, 2004).

Mathematics specialists also help to guide PLCs within their schools as they develop a common content language and provide professional development for teachers to acquire new pedagogical skills and strategies (Campbell, Ellington, Haver, & Inge, 2013; Fennell, McCord Korbett, & Wray, 2013; Showers, 1985). The shared vision and values of these individuals within these PLCs not only leads to a collective commitment to one another but also allows for continuous improvement and professional learning (Ontario Ministry of Education, 2005; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). While mathematics specialists are expected to create and support PLCs within their schools, there is minimal research on communities of learning for mathematics specialists. Chval and colleagues (2010) studied the experiences of three novice mathematics coaches as they transitioned from their previous roles as classroom teachers. The coaches were expected to allocate 20% of their work hours to professional development, yet they expressed concern and guilt that other teachers would not value this professional obligation. The research team also reported that the coaches appreciated the

opportunity to share challenges and strategies as part of a mandatory district-wide monthly professional development (Chval et al., 2010, p. 212).

Prior research on the complexity of coaching roles (Baker et al., 2017; Killion, 2009), the need for professional development to sustain content and pedagogical expertise, and the contextual isolation that mathematics specialists may experience suggest an important place for the sustained support that a PLC of mathematics coaches from a variety of schools could provide. Hord (1997) elaborated on a "professional communities of learners" within schools as defined by Astuto, Clark, Read, McGree, and Fernandez (1993).

> …teachers in a school and its administrators continuously seek and share learning, and act on their learning. The goal of their actions is to enhance their effectiveness as professionals for the students' benefit; thus, this arrangement may also be termed *communities of continuous inquiry and improvement*. (Hord, 1997, p. 6)

Stoll and colleagues (2006) reviewed literature on PLCs and concluded that building capacity for sustained school improvement is broadly dependent upon positive learning, organizational conditions and culture, and an infrastructure of support. They studied literature on building capacity not only within schools but between schools. Hargreaves and Giles (2003) asserted that networked learning communities are synonymous with PLCs as both become social processes that generates knowledge.

> A network increases the pool of ideas on which any member can draw and as one idea or practice is transferred, the inevitable process of adaptation and adjustment to different conditions is rich in potential for the practice to be incrementally improved by the recipient and then fed back to the donor in a virtuous circle of innovation and improvements...in other words, the networks extend and enlarge the communities of practice with enormous potential benefits... (Hargreaves, 2003, p. 9)

Meeting the Needs of Mathematics Specialists

This research chronicles the evolution from a university-facilitated monthly professional development for mathematics specialists to a reciprocal partnership between university teacher educators and K-12 teacher leaders. This cohort of mathematics specialists began by discussing effective teaching practices from NCTM *PtA* (2014) and the implications for effective coaching practices. As trust between mathematics specialists increased, they shared contextual experiences and supported one another in developing strategies to sustain improvements impacting student understanding within their own schools. They became a community committed to collaborative critical reflection on their practice and accountable to one another for their professional growth. The resulting professional development model fostered the organic emergence of a unique and sustainable PLC of mathematics specialists.

This professional development experience took place in one of the first states to offer a specific licensure endorsement for mathematics specialists. To support individuals obtaining this state endorsement, one university situated in a large metropolitan region developed a graduate program in which students would also earn a master's degree in educational leadership. As they completed the program, students shared that they would miss staying abreast of current issues in mathematics education with a collaborative network of like-minded peers from their courses. In

response to this desire for continued learning, the university created an annual statewide Mathematics Specialist Institute (MSI) in 2013 as an opportunity for mathematics specialist learning and networking. The institute supported not only program alumni, but also others in similar positions throughout the region. Over 50 teaching professionals were in attendance at each institute.

Data collected from the yearly institutes indicated that while alumni from mathematics specialist programs across the state valued their formal professional development experiences, they desired additional opportunities to gather with their peers and continue the collaborative conversations about the roles and responsibilities of mathematics specialists. They sought the opportunity to "network, grow and share ideas" through rich conversations with their peers. Additionally, institute participants valued the confirmation that the position, though isolating and complex, was ever-changing and important.

> We have known as a profession what good practice should look like for a long time but we are still struggling with how to implement it with teams of teachers. We wear many hats but in order to be effective we need to stop and reflect to assess needs and prioritize. Collaboration supports this. (Participant, 2015 MSI)

In an attempt to provide continuing support through collaborative groups, researchers from two universities partnered to design a framework for professional development that centered on purposeful sequencing of chapters of NCTM *PtA* (2014) and strategies for implementing highleverage mathematics teaching practices within school communities. They established two groups in distinct regions of the state and collaborated to develop monthly agendas for mathematics specialists to gather and continue the conversations started at the MSI. As both of the university facilitators previously worked in K-12 public schools as mathematics specialists, they understood how classroom teachers could perceive mathematics specialists as outsiders due to their responsibility for measurable improvement in student outcomes. The monthly conversations needed to provide a space for participants to come and to share their contextspecific challenges in a low-stress and safe environment with peers who held similar responsibilities. The experiences of one of the university facilitators and her participants is chronicled in the remainder of this article.

Designing the Professional Development

Our study began as an exploration of how mathematics specialists navigated the implementation of the *Principles to Actions* (2014) within their school settings. Our goal was to provide monthly support that met the needs of our community (as identified by the MSI) and to assist mathematics specialists as they further developed both their skills and the skills of the teachers they worked with. At each meeting, participants discussed purposefully selected topics (see Table 1) from *Principles to Actions* (2014) and explored how these topics connected to the challenges or barriers they faced at their schools. It poses questions and provides vignettes which guide teaching professionals as they connect reform-based standards and practices for mathematics learning to classrooms. While designing each session, university facilitators targeted a specific *Principles to Actions* essential element and teaching practice that would

encourage mathematics specialists to engage in critical conversations grounded in current research.

Table 1

Principle to Actions (2014) Monthly Topics and Participation

Month	**PtA (2014) Essential Elements and Teaching Practices**	**Monthly Attendance**
August	Establishing Mathematical Goals to Focus Learning Access and Equity	9 Participants
September	Implement Tasks that Promote Reasoning and Problem Solving Use and Connect Mathematical Representations Curriculum	8 Participants
October	Facilitate Meaningful Mathematical Discourse Tools and Technology	8 Participants
November	Pose Purposeful Questions Build Procedural Fluency from Conceptual Understanding	4 Participants
December	Support Productive Struggle in Learning Mathematics	6 Participants
January	Assessment	6 Participants
February	Elicit and Use Evidence of Student Thinking Professionalism	5 Participants
March	Plan Mathematics Specialist Institute panel presentation	7 Participants
April	Attend and present at the Mathematics Specialist Institute	7 Participants

The Mathematics Specialists

Participants were either self-selected from a survey of statewide MSI attendees or invited by an individual who had attended the MSI. The group consisted of nine Caucasian, female mathematics teacher leaders from four different school divisions within a 30-mile driving radius of the meeting location (see Table 2). Individual school representation ranged in grade (K-12), structure (public and private), and Title I status. Participant ages ranged from mid-20s to late50s. Seven participants were either alumni of or enrolled in a mathematics specialist endorsement program from the facilitating university. The experience of the mathematics specialists serving in a leadership position ranged from novice (0-3 years) to veteran (>3 years).

Table 2

Participant and Work Leadership Experience

Participant	**Job Title**	**Mathematics Leadership Experience** (novice or veteran)	**Mathematics Specialist (MS) Program**
Christina	K-12 Division Mathematics Supervisor	Veteran	No MS Program
Jackie	6-8 Mathematics Coach	Veteran	Alumni
Elizabeth	K-6 Mathematics Coach	Veteran	Enrolled
Laura	K-6 Interventionist	Novice	No MS Program
Kerri	K-6 Mathematics Coach	Veteran	Alumni
Linda	6-8 Lead Mathematics Teacher	Novice	Enrolled
Cora	6-8 Classroom Teacher (75%) and 6-8 Mathematics Coach (25%)	Novice	Enrolled
Ellen	STEAM Curriculum Coordinator (50%) and K-6 Mathematics Teacher (50%)	Veteran	Alumni

Shelley	K-12 Mathematics Coach and Division Specialist	Veteran	No MS Program

Recording and Analyzing the Experience

To gain a rich understanding of the informal professional development structure, monthly meetings were audio recorded and written reflections from both the participants and university facilitator were collected. The university facilitator continually reflected on her role within the group. The second and third authors served as critical friends throughout the design and implementation of the professional development. By revisiting audio recordings of each meeting, the research team assisted the facilitator in the refinement of future agendas. Openended reflection questions centered on the support provided within the professional development and the connectedness to individual's professional goals and school-based contexts. Participant artifacts were evaluated at the end of each session and used to modify the professional development structure in response to participant questions and reactions. This process maximized stakeholder involvement and negotiation in design decisions (Fishman, Penuel, Allen, Cheng & Sabelli, 2013; Penuel, Fishman, Yamaguchi & Gallagher, 2007) and targeted specific participant needs through the authentic integration of theories and research.

An initial set of codes for qualitative analysis were obtained via Invivo coding to capture the participants' perspectives using specific words and terms verbatim. This allowed the study to "prioritize and honor the participant's voice" (Saldãna, 2016, p. 106). Pattern coding was used to group the resulting summaries from first cycle coding into a smaller number of categories to support the identification of emergent themes and create more meaningful units of analysis prior to the categorization of themes (Saldãna, 2016). Initial categories were subjected to constant comparison and analysis across all data sets to develop a working set of emergent themes as described by Strauss and Corbin (1998). The three emergent themes of seeking learning, sharing learning, and acting on learning were consistent with the researcher team's observation that the informal professional development structures for mathematics specialists had evolved over the course of the year into a PLC. These three themes were then aligned with Hord's (2004) five dimensions of a PLC.

The Emergence of a Professional Learning Community

Each mathematics specialist approached the monthly meetings seeking to improve her practice and further her professional knowledge. As participants shared their roles and responsibilities and grew to value one another's expertise and experience within the structured discussions, they began to develop agency to define and enact meaningful change informed by their newfound community of practice. Conversations shifted from anecdotal descriptions of roles and challenges to deepening reflection on the impact of their actions within their schools. Participants began by seeking to learn about their practice and discovered the affordances of sharing perspectives on teaching and learning. Finally, they began to act on their learning by advising and challenging one another in the pursuit of instructional change. While all of the

participants had engaged in PLCs in their schools as leaders or supporters of PLC leaders, they valued this collaboration with mathematics specialists from other schools as a novel and empowering experience. Through this process of seeking, sharing, and acting on learning, the mathematics specialists and the university facilitators became a networked learning community exhibiting Hord's (2004) five dimensions of PLCs.

1. Shared Values and Vision

The mathematics specialists came because they wanted to reflect on their practice beyond the walls of their school communities. They created a community of trust and open communication to build a culture of "academic optimism" (Hord, Roussin, & Summers, 2010, p. 37) through which they could make a difference for mathematics teachers and students. Their coaching roles, whether established or new, evoked an uncertainty that left them looking for knowledge and seeking solutions to problems of their practice. Participants were looking for ways to help move their teachers forward to help each and every student to realize her potential (Hall & Hord, 2001).

> This is the first time that I am teaching sixth grade math and my team is veteran teachers who have been teaching for a long time. They have never done anything but textbook teach so they are very attached to the algorithm. I was given the lead role over them to show them what manipulatives are, and I am looking forward to learning from the group, sharing, and getting help. (Ellen, STEAM coordinator and K-6 mathematics teacher)

Although three of the participants had previously completed a mathematics specialist endorsement that emphasized mathematics content, pedagogy, and leadership skills, they communicated a desire to collaborate with other mathematics specialists to support their transition from K-8 classrooms to positions involving greater leadership. One participant who served as an interventionist within her building wanted to gain knowledge of the mathematics specialist program at the university. She shared that she wanted to network with and learn from individuals who had more experience. "I want to be in a community with other people who are math specialists, get my feet wet a little and see what other people do outside of the district" (Laura, K-6 mathematics interventionist). Another participant, Cora, reflected on her experiences with the PLC as a novice teacher leader.

> I was a little intimidated at first because I'm in grad school and new to the leadership position. A lot of the people [in our group] were very established within their communities. But as the year progressed, I really felt like I was around people that I could learn so much from and to get so many takeaways. I would be able to apply them (strategies for working with teachers) in the next day or the next week...and then the next month being able to come back and talk with the group about that and have a discussion about … what I tried out. (Cora, 6-8 mathematics teacher and coach)

Cora articulated a commitment to improving student learning which was uniquely supported by this emerging PLC of mathematics specialists with a common vision.

2. Shared and Supportive Leadership

While their involvement may have been initially motivated by opportunities to learn through *PtA* with the leadership of the university facilitator, the mathematics specialists stayed for the shared perspectives from supportive peers and for a safe forum in which to reflect critically on their practice with the community they were developing. During the initial sessions, the mathematics specialists shared their professional backgrounds and developed group norms. They familiarized themselves with one another and looked to the university facilitator to define the learning that they needed. At the same time, the university facilitator communicated her vision for a responsive professional development. "My thinking is that this (professional development) is whatever you want it to be."

As the monthly meetings progressed, the mathematics specialists transitioned from seeking answers from the university facilitator to turning to their peer group for support and guidance. As this community of "continued inquiry and improvement" (Hord, 1997, p. 1) evolved, participants shared resources and generated solutions. The mathematics specialists grew to value the collective content knowledge and experiences to which each individual contributed. During this transition, they became aware of their leadership capabilities and exuded an increased level of confidence in their own skill sets as learners and leaders.

> This is my third year of being a specialist, the amount of professional development and learning from other people, reading from [*Principles to Actions]*, Cora sending me texts and getting books and resources from our meetings. I mean just the amount of stuff that I can casually read through is tremendous. (Linda, K-6 lead mathematics teacher)

As the mathematics specialists gained confidence in their own expertise, they were no longer looking to the university facilitator to direct their time together. Although the university facilitator still served as the organizer of the meetings and determined the logistics and topics for discussion, she did not offer as many anecdotes and suggestions. Participants gained agency with the transfer of authority within the meetings. The university facilitator was no longer prompting and responding as "the sage on the stage" (Hord et al., 2010, p. 55). The academic conversations were initiated and led by the mathematics specialists. In one case, a middle school teacher sought to improve discourse in Algebra I classrooms by encouraging teachers to elicit and examine student thinking.

> Cora: I've been re-doing all of our assessments, taking out stuff that's not necessary and then incorporating a lot of assessment questions that are open ended, and including student explanations which I don't see a lot of - especially in Algebra I and higher. Students just solve the problem and teachers grade it. Which is a confrontation I had recently. But what kind of things do I bring up to people to get them to want more [student] discourse?
>
> Elizabeth: Would it help to ask the teacher, "What do you do if the child gives you the wrong answer?"
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> Linda: Then you could work with the teacher to have the student explain what they did or have another student try to explain their ideas to see if there's an understanding for what they did.
>
> Facilitator: And that's my challenge to you. As individuals who are leaders, you know

> how to do this. How do you foster that growth in your teachers? Because you can't be in every classroom.

The university facilitator recognized that participants' questions needed to be answered by their peers. She provided appropriate guidance on the side to build their efficacy as knowledgeable teacher mathematics leaders.

3. Supportive Conditions for the Maintenance of the Learning Community

The requisite infrastructure for a PLC includes both physical conditions, including time and resources, and people's capacities to learn and to change (Hall & Hord, 2001). The university facilitator provided a copy of NCTM *PtA* to each of the participants. She anticipated that the readings and discussions would connect to the more formal learning experiences of the specialist endorsement programs yet offer the flexibility of an informal book club. Monthly agendas were structured to elicit specific coach-teacher parallels to the teacher-student actions in illustrations of effective teaching practices within *PtA*. The discussions were intended to highlight how mathematics specialists could support teachers in enacting the practices. While the assigned readings provided direction for conversations between the attending professionals, it was important to the university facilitator that participants did not perceive that the readings were mandatory. An off-campus location central to all participants was purposefully identified to communicate the informality of the interaction and to encourage dialogue between participants. Meetings were scheduled for 90 minutes in the evenings, but discussions often continued beyond the allotted time as participants valued both the supportive relationships and learning from one another. Monthly meetings were structured in a manner that promoted receptiveness to participant concerns and affirmation of their ideas.

Several of the participants reflected on the conditions which both met their individual needs and furthered their continual improvement as mathematics leaders.

> It was pretty much a support group. It was just collegiality. I think that now that I've read a lot of research on an effective PLC, we were a PLC. That's what we were. But we were supported across divisions and our group had that broader perspective of how are we going to help our teachers and our students. (Elizabeth, K-6 mathematics coach) I think communication is huge and just being able to be completely open and vulnerable was very valuable. A lot of times you can't being the only one at your school. Being able to have that outlet is very valuable. (Cora, 6-8 mathematics coach and teacher)

The participants articulated that discussing the effective teaching practices of NCTM *PtA* (2014) was the catalyst for sharing their struggles and their needs. The monthly topics identified by the university facilitator prepared them for conversations that helped them to improve their practice and to transform difficult situations into learning opportunities for all.

4. Shared Personal Practice

PLCs must be grounded in relational conditions of empathetic listening and transparent discussion (Hord et al., 2010). The mathematics specialists were surrounded by peers who enthusiastically shared their passion for the teaching and learning of mathematics as well as their

professional responsibility for developing and fostering the mathematical teaching practices of others. “I find this very affirming in what I am trying to implement in my school. It also reinforces the [mathematics specialist] classwork that I'm doing” (Elizabeth, K-6 mathematics coach).

They discovered a freedom to share their struggles with professional peers; they were not able to engage in these types of conversations within their schools for fear of ruining relationships or breaking confidences. Although one to two participants attended each of the meetings without reading *PtA*, the mathematics specialists connected to the text and centered many of their conversations on practices from the book. The participants were already fluent in the mathematics teaching practices and were implementing them within their own contexts as teachers of mathematics. The challenge became how to support instructional shifts within their schools that were centered on these practices. Even though each participant came from a unique school or division context, they discovered that each had similar goals and desires for their communities. They valued and trusted perspectives from outside of their own contexts. I was thrilled to talk to somebody outside of my own division. I've been wanting to do something like that, but never took the time to search it out myself. (Jackie, 6-8 mathematics coach)

> What brought me back was that I need perspective not just from my own county. I think sometimes we get so immersed in [our district’s way] that it's really fresh air to listen and hear others. (Kerri, K-6 mathematics coach)
>
> Sometimes I get bogged. I feel like I’m the only one who’s thinking about these [conceptual perspectives], and so it’s nice to come talk to people who are on the same page. It’s like a check-in. (Cora, 6-8 mathematics teacher and coach)

Each of the mathematics specialists came to the professional development with individual challenges. Over the course of the year, the PLC fostered a collaboration in which these individual challenges became common challenges answered with collective solutions.

5. Collective Learning and the Application of that Learning

With shared reflection and accompanying inquiry (Hall & Hord, 2001), the meeting outcomes shifted from expression of sympathetic understandings of the complexity of their roles to specific strategies for making instructional shifts within their school communities. Initially the mathematics specialists’ conversations centered on frustrations within their schools, such as the challenges of building relationships with resistant teachers. Frustrations also centered on the unwillingness of some teachers to change the way they teach mathematics. “Teachers think *Principles to Actions* is too much.” and “Teachers don’t see connection between high-level tasks and teaching.”

As participants committed to a shared investment in improving their practice, their participation grew beyond the simple seeking and sharing of knowledge and became a call to action to inspire instructional shifts within their buildings. This shared responsibility and ownership allowed this new community of mathematics specialists to seek solutions and to ask for strategies from their peers. *How can I implement a change in practice when students are passing their assessments and there is no visible need for change? How do we get teachers to look at the standards as intermingled and not isolated? How can we support the unpacking of*

standards in a meaningful manner that does not become routine, yet remains dynamic to respond to team changes over time?

Analysis of the discussions underlying these broader questions yielded noteworthy conversations on longstanding problems of practice related to procedural fluency and conceptual understanding. Questions they asked of one another centered on changing mindsets of various stakeholders and making instructional shifts within their communities. Each was attempting to increase the value assigned to conceptual understanding by teachers, administrators and students in their school buildings.

One of the participants posed the question, "How do you handle fact fluency in your building?" The varied responses encouraged the participants to reflect more deeply on unique perspectives informed by different roles and responsibilities. Each had grappled with developing conceptual understanding in students and meeting the constraints of expected outcomes. Linda: To me, it's all about the automaticity. I don't care if they can do it in three minutes. If they can do it quick enough where they aren't sitting there and struggle on their long division because they don't know their two times 12 - it's not there.

> Christina: So you're happy with a student deriving it, not knowing it automatically? Not storing it in memory?
>
> Ellen: It's kind of a yes and no thing. I want them to be so they're not spending all of their time stuck on that. So my fifth and sixth graders, they do need to know [their multiplication facts] especially their zero through 12's. But if they don't know a fact then I can get them to use compensation or they can take one that they know and quickly go up. I'm okay with that, and I get flack for it, but I don't care. I don't care.
>
> Kerri: I don't think it's about speed. I think it's about fluency. And it is that I know how to do it, but it's not that I have to do it in 20 seconds or three seconds or whatever it is.
>
> Christina: But where is the threshold when you're testing? When you're dealing with children, and how you know they have achieved? And how do you hold a teacher accountable for getting them to that threshold?

As supporting students' conceptual understanding became a focus, the mathematics specialists centered their conversations on analyzing representations across the K-12 spectrum to improve the effectiveness of teaching practices within their schools.

Discussion

The monthly mentoring experiences were originally designed as a university-facilitated professional development in response to the expressed needs of individual mathematics specialists. They became a structure for a PLC centered on the construction of professional knowledge. The NCTM *PtA* readings and discussions provided legitimacy which moved the participation beyond a social supportive gathering toward a forum with professional purpose. The sessions provided a space for participants to build norms for collaboration and to act with a coherence that allowed a PLC to emerge. This PLC drew upon participants' shared expertise and demonstrated how opportunities for critical and coherent reflection can contribute to the professional growth and empowerment of mathematics specialists.

The important opportunities to learn and collaborate within a PLC across schools were

experienced not only by the mathematics specialists but also by the university facilitator. Her vision for this professional development experience had been to bring together knowledgeable others in teacher leadership positions to support and learn from one another. However, there was an initial disconnect between this vision and the reality of each meeting; the mathematics specialists were looking to the university facilitator for answers. After analyzing initial meeting transcripts and reflecting on her actions, the university facilitator began to redirect questions to other PLC members to encourage the participants to seek answers from one another. As the monthly meetings progressed, the mathematics specialists learned to value the knowledge of their peers and more importantly their own contributions to the shared construction of knowledge within the PLC.

Our findings suggest that professional development for mathematics specialists requires more than strategies from outside experts. The participants in this experience valued the perspectives they gained by collaborating with peers from different grade levels, schools, and divisions.

> I want a presence for math and I want it now. I want to build total capacity. [Professional development] groups like this do that for us. If it meets once a month and is low commitment, then you draw people in and they start seeing themselves as being math leaders. They get conversant and they feel comfortable in this milieu so we start building capacity in our buildings. (Christina, K-12 division mathematics supervisor)

Mathematics teacher educators situated in universities that have regional outreach are uniquely positioned to facilitate professional development experiences that may become "communities of continuous inquiry and improvement" (Hord, 1997, p. 6). It is our hope that the teacher education community will see the potential for university-facilitated PLCs to become flexible and ongoing supportive structures for teacher leaders. The university can further participant knowledge of research on pedagogy and content, while the K-12 school-based participants can provide an important lens on implementation of research-based practices. Teacher leaders also benefit from opportunities to engage with others in similar leadership positions in other schools. These experiences advance their own practice as they advocate for more effective teaching and learning in their schools.

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A professional learning community (PLC) is a method to foster collaborative learning among colleagues within a particular work environment or field. It is often used in schools as a way to organize teachers into working groups of practice-based professional learning. The phrase professional learning community began to be used in the 1990s after Peter Senge's book The Fifth Discipline (1990) had popularized the idea of learning organizations,:2 related to the idea of reflective practice espoused by