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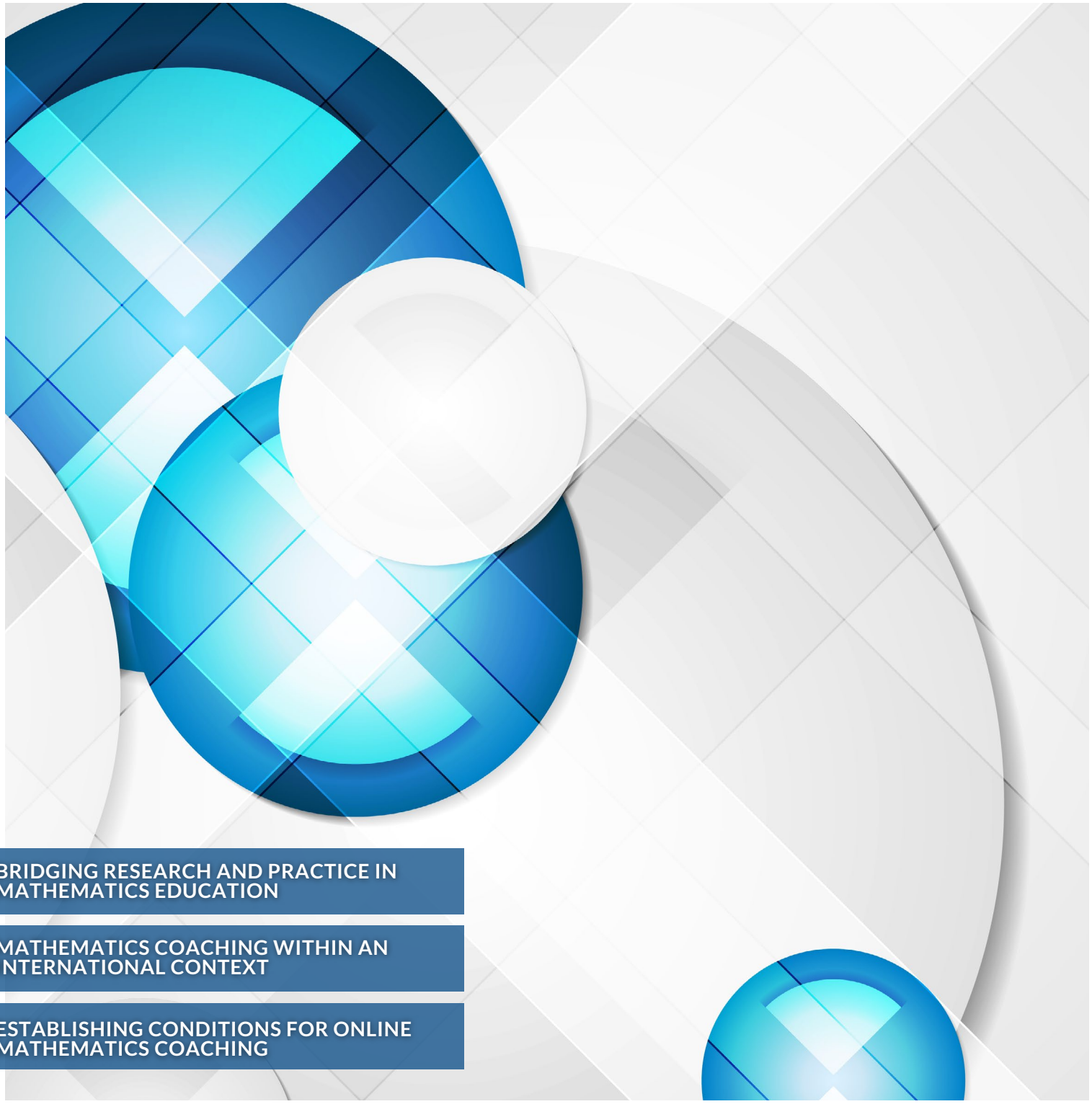

BRIDGING RESEARCH AND PRACTICE IN MATHEMATICS EDUCATION

MATHEMATICS COACHING WITHIN AN INTERNATIONAL CONTEXT

ESTABLISHING CONDITIONS FOR ONLINE MATHEMATICS COACHING

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The editors of the ***NCSM Journal of Mathematics Education Leadership (JMEL)*** are interested in manuscripts addressing issues of leadership in mathematics education which are aligned with the NCSM Vision.

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NCSM–LEADERSHIP IN MATHEMATICS EDUCATION

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About NCSM

NCSM Mission Statement

NCSM is a mathematics education leadership organization that equips and empowers a diverse education community to engage in leadership that supports, sustains, and inspires high quality mathematics teaching and learning every day for each and every learner.

NCSM Vision Statement

NCSM is the premier mathematics education leadership organization. Our bold leadership in the mathematics education community develops vision, ensures support, and guarantees that all students engage in equitable, high-quality mathematical experiences that lead to powerful, flexible uses of mathematical understanding to affect their lives and to improve the world.

High-quality leadership is vital to this vision. NCSM is committed to:

Developing and Informing Vision

- Provide leadership to influence issues and policies affecting mathematics education in ways consistent with the mission and vision of NCSM;
- Equip leaders to be critical consumers of educational information, research, and policy to become change agents in their communities;
- Support leaders to develop an actionable vision of mathematics instruction consistent with a view of mathematics as a sense-making endeavor.

Ensuring Support to All Stakeholders

- Develop networking and communication opportunities that connect the mathematics education community as well as the broader education community;
- Equip leaders with the tools to create and sustain systems that fully align with the vision of mathematics and mathematics instruction promoted by NCSM;
- Equip leaders with the understanding, knowledge, and skills to continue their own personal growth, support emerging leaders, and further develop excellence in mathematics teaching.

Guaranteeing All Students Engage in Equitable, High-Quality Mathematical Experiences

- Provide advocacy and support regarding issues and policies affecting mathematics education in ways consistent with the mission and vision of NCSM;
- Provide resources for the implementation of research-informed instruction to ensure students engage in relevant and meaningful learning experiences that promote mathematics as a sense-making endeavor;
- Advocate for each and every student to have access to rigorous mathematics that develops their understanding, skills, and knowledge, along with the confidence to leverage their learning, in order to improve their world.

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COMMENTS FROM THE EDITORS

Heather Crawford-Ferre
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Mathkind Global

As spring arrives, the academic year has offered enough time for something important to happen. Teachers have watched their students long enough to recognize how they respond when they are confused and how they behave when a new idea is beginning to take hold. Leaders have spent enough hours in classrooms and workshops to see the habits and dispositions their colleagues carry into professional learning. The early weeks of getting acquainted have given way to something deeper: a working knowledge of the people we serve, shaped by months of close observation and shared experience.

This kind of knowledge is hard-won, and it changes the nature of leadership. When you truly know the students in front of you or the teachers beside you, the temptation is to translate that knowledge into directives. You have seen what works. You have noticed where someone is stuck. The pull toward telling is strong. And yet the most effective leaders we know resist that pull. They understand that deep knowledge of another person's practice calls for humility, not prescription. It calls for conviction about what matters paired with restraint about how to get there. Presence in classrooms and professional learning spaces builds the relational and intellectual foundation that makes responsive leadership possible, but only when that presence is accompanied by a genuine willingness to listen before acting.

The three articles in this issue of the Journal of Mathematics Education Leadership (JMEL) each illuminate a different dimension of what it means to lead with that kind of informed humility.

In "Mathematics Coaching Within an International Context: An Intersection of Cultures, Challenges, and Perspectives," Bennett and Johnson follow the four-year experience of a U.S.-trained mathematics coach who took on a coaching role in an international American curriculum school in the Middle East. The article traces what happened when the coach's familiar frameworks met an unfamiliar cultural context. A mathematical task that had worked well in U.S. classrooms fell flat when students could not connect to its imagery, and the coach had to confront the limits of his own assumptions about what makes a task accessible. Bennett and Johnson's findings remind us that effective coaching depends on understanding the lived cultures of the students and teachers we support. This lesson extends well beyond the international context. Wherever we lead, our assumptions about what will work must be tested against what we actually observe, and we must remain open to revising those assumptions when the evidence calls for it.

In "Bridging Research and Practice in Mathematics Education: Exploring District-Level Mathematics Specialists' Responsibilities and Professional Learning Needs," Baker, Hjalmarson, and Fennell present an exploratory study of district-based mathematics specialists (DMSs) in Virginia. Their findings reveal considerable variability in what DMSs are called and what they are asked to do across districts. Despite this variability, common themes emerged: DMSs play a central role in supporting teachers and building coherent instructional systems. At the same time, many DMSs described the isolation of being the sole mathematics leader in their district and expressed a strong desire for professional learning focused on current research and on designing challenging, problem-solving experiences with teachers. Baker and colleagues underscore the need for professional organizations and districts to invest in structured collaboration and mentorship so that these leaders can continue to grow in a role that remains under-defined and under-researched.

In "Establishing Conditions for Online Mathematics Coaching: How Coaches Initiate Partnerships With Teachers," Gillespie, Saclarides, Tegeler, Prummer, and Roberts examined how ten experienced mathematics coaches facilitated preliminary conversations with teachers before beginning online coaching cycles. Using an analytic framework adapted from the medical field, the authors analyzed the coaches' discourse and found that rapport building was the most prevalent category of talk, with emotional rapport building especially prominent across all ten coaches. These experienced professionals, who could have led their initial conversations with instructional directives, instead prioritized listening and communicating partnership. The study offers a detailed look at how coaches can lay the groundwork for productive relationships in a short amount of time, and it provides a practical framework that leaders can use to prepare coaches for the relational work that precedes instructional work.

Taken together, these articles ask us to consider what it means to be fully present with the people we serve. Bennett and Johnson show us the cost of leading without sufficient cultural understanding. Baker, Hjalmarson, and Fennell reveal how much we still need to learn about supporting the leaders who sit at the intersection of district policy and classroom practice. Gillespie and colleagues demonstrate that even experienced coaches recognize the importance of beginning with relationships before moving to content. In each case, the message is consistent: knowledge of the people we work with is the foundation of effective leadership, and that knowledge must be held with care.

As you engage with these articles, we invite you to reflect on your own leadership practice at this point in the academic year. What have you learned about your students and colleagues that you did not know at the start of your academic year, and how has that knowledge reshaped the way you approach professional learning and instructional support? We are grateful, as always, for your commitment to thoughtful leadership in mathematics education, and we hope this issue of JMEL offers ideas worth carrying as you complete your academic year.

MATHEMATICS COACHING WITHIN AN INTERNATIONAL CONTEXT: AN INTERSECTION OF CULTURES, CHALLENGES, AND PERSPECTIVES

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ABSTRACT

Across the United States, mathematics teacher leaders often hold similar beliefs and operate under professional norms about the teaching and learning of mathematics. However, teaching in culturally rich and diverse international schools brings unique challenges for mathematics coaches. As such, this qualitative study centered on the 4-year experience of one U.S.-trained educator as they started a new role as a mathematics instructional coach in an international school in the Middle East. Findings highlighted challenges in understanding the interplay between local and school cultures and structural challenges of international schools that impacted the mathematics coach's work. Although the study was situated in an international context, connections to similar challenges in the United States were strong and are briefly discussed. These findings yielded further insight into the considerations leaders of mathematics education should examine when working with and supporting students, teachers, and administrators from culturally rich and diverse backgrounds.

Keywords: international schools, mathematics coaching, teacher development.

Introduction

Instructional coaching has emerged as an important means by which the quality and nature of teaching and learning mathematics can be improved (McGatha et al., 2017). Over the past decade, numerous studies and considerable evidence have led school and district personnel to create coaching positions and, at times, cohorts of coaches to provide timely support for teachers through job-embedded professional learning, curricular and assessment development, and building or district leadership initiatives (Hartman, 2013; Rudd et al., 2009; Russell et al., 2020). Many of the major challenges relating to implementation of these coaching programs and individuals stepping into mathematics coach roles have been well documented (Campbell et al., 2013; McGatha & Rigelman, 2017), although much of the research has focused on models or educational systems based in the United States and has not adequately captured the lived experiences of instructional coaches in international schools in culturally rich and diverse contexts. For leaders of mathematics, there is a need to deeply understand the lived cultures of students and mathematics teachers who support these students to better understand how these lived cultures both align with and diverge from school culture and intended learning outcomes for all students.

International schools are incredibly diverse in their philosophical designs, curricular structures, student bodies, and teaching faculty (Bunnell et al., 2016). Compared to most schools in the United States, international schools are private schools and operate like their own miniature school district. The director or head of school has all responsibilities of a district superintendent with principals for primary and secondary grades. Globally, there were over 14,000 international schools with nearly 7 million students attending them as of 2025 (ISC Research, n.d.). The students who attend these schools often are children of expatriates from many different countries who work for multinational organizations, ambassadors or other governmental workers, or immigrants. Additionally, international schools may enroll students whose parents are citizens of the host nation but who want their children to have a more globally minded educational experience. For most of these students, they navigate three unique cultures: their parents' home culture, the culture of the host country, and the culture developed from the community of people who are also growing up internationally (Doherty et al., 2023). Mathematics educational leaders who work in these contexts must be aware of and navigate this intersection of cultures to ensure all students have equitable access to high-quality learning experiences.

International schools often adopt a philosophy based on a particular nation; examples include British, American, Australian, and Indian curriculum schools, each of which has their own nuanced ways of approaching teaching and learning. Although some international schools adopt curricular structures and standards from the United States and may seem to operate similar to schools in the United States, they face many different challenges not typically found in U.S.-based schools (Halicioglu, 2015). For example, it is common to have 30 or more different nationalities in a K–12 international school with enrollment of only a few hundred students across all grades. Although some teachers may be local hires (i.e., citizens of the host country), most foreign hires are teachers whose cultural backgrounds are just as diverse as those of their students, but the teachers' cultures are often substantially different from the communities in which they teach.

Collectively, the cultural, structural, and philospophical complexity of international schools shapes the sociocultural

ways of engaging in education, which in turn can impact the ways in which support systems (i.e., use of mathematics coaches) are implemented and received (Pearce, 2013). Likewise, local cultural ways of viewing the work of schools influence how schools are designed, operated, and otherwise supported by the community, regardless of what standards or curricular frameworks they may use. All these factors can impact the work of mathematics leaders, meaning the cultural ways of being for U.S. mathematics coaches and mathematics teacher leaders trained in the United States may not align with the local culture and school culture. When these different cultural ways of viewing teaching and learning intersect, growth in professional learning and attainment of student learning outcomes can be slow to develop. As such, the purpose of this study was to capture the lived experiences of one mathematics coach, new to instructional coaching, who worked in an international American curriculum school to better understand challenges they faced in systematically supporting mathematics teachers in their own work.

REVIEW OF LITERATURE

An ever-growing body of research has suggested instructional coaching can be an effective means for supporting student learning and developing teachers' praxis (Harbour & Saclarides, 2020; Killion et al., 2020; McGatha et al., 2017; NCSM, 2019), which are key priorities of principals and other school leadership teams. Instructional coaching can provide a range of benefits (e.g., targeted support for developing teachers' pedagogical content knowledge, assessment practices, ability to attend to nuances in students' thinking; Russell et al., 2020) as well as a more comprehensive and holistic support for ongoing school improvement (Gibbons et al., 2017). As such, an instructional coach serves a key role in supporting the work of the leadership team while being an advocate and collaborative resource for teachers.

However, becoming an instructional coach is not without its challenges. One of these challenges is ill-defined roles and responsibilities (Chval et al., 2010), which can lead to uncertainty in the details of coaches' jobs. Other challenges include the loss of access to a professional network of collaborators or "thought partners" to understand, develop, and implement initiatives (Ippolito & Bean, 2019) and to build impactful relationships with teachers because there are too many teachers for coaches to work with them in a meaningful, consistent, and reliable manner (Moody, 2019). Furthermore, many new coaches have limited experiences or training in supporting adult learners (NCSM, 2019) and may not know how to engage in collaborative coaching (Placa, 2023) to best support these teachers. When these challenges go unaddressed, they can lead to a decrease in a coach's effectiveness and may hinder their self-efficacy and identity as an instructional coach (Birmingham et al., 2013; Ortmann & Roehrig, 2019), which can functionally lead to the downfall of any coaching initiative.

Given the complexity of an effective instructional coach's work, the cultural context in which this work occurs cannot be ignored. Within an international school context, diversity and cultural significance are paramount (Hill, 2014); thus, the coach's work takes on an added level of complexity because their own personal beliefs and cultural identities may not align entirely to the local cultures. This review of the literature focused on coaching transitions, school culture, and developing a coaching identity grounded in an international school context. To understand the ways in which these three aspects are impacted by the school context, the nature and complexity of international schools is discussed first.

International Schools

Teaching internationally has a long history, and demand for teachers has continued to increase worldwide (UNESCO Institute for Statistics, 2015). Globally, nearly 5 million students attend international schools, and it has been projected that this number could reach over 8 million students by 2025 (Bunnell et al., 2016). In some regions of the world (e.g., the Middle East), the growth of new schools has been tremendous, with student enrollment growing by nearly 9% each year (Knowledge and Human Development Authority, 2021). Such a continued increase also means teachers from all over the world are being recruited to work internationally, immersing themselves in cultures other than their own home cultures.

Cross-national work experience, like teaching internationally, brings with it a host of benefits that may not otherwise be realized when teaching solely in one's home country. Bodycott and Walker (2000) found teachers who worked internationally often came to understand their own cultures from a different perspective, and Ospina and Medina (2020) found teachers became more culturally aware and developed their pedagogical expertise because they worked with teachers from different countries. Accordingly, working in an international school creates beneficial outcomes for the individual teacher, the school, and the profession (Burman et al., 2006; Moorhouse & Harfitt, 2021). For the mathematics coach and the ways in which they can grow professionally, these potential benefits also mean there are unique opportunities worth considering that come from working in international schools.

However, there are also challenges that some teachers may be unaware of when they first move overseas and begin teaching in a new country and culture. Hutchison and Jazzar (2007) found these issues frequently centered on experiencing culture shock, adapting to school systems unlike their home systems, and encountering different communication barriers and other cultural influences (e.g., religion; Miller, 2018). Additionally, Amaro-Jiménez (2012) found educators teaching abroad were unprepared to meet the needs of culturally diverse students in many instances. Although the excitement and glamour of teaching in a foreign country appeals to many teachers at first, the absence of family and friends from home can make adjusting to a new culture difficult (Ospina & Medina, 2020), especially for many U.S. teachers who lack a broader understanding of what cross-national and cross-cultural work experiences entail.

Being aware of these challenges can be difficult because it is hard to know what one does not know, yet these challenges are very real and impact educators new to working internationally in their personal lives and professional work. To that end, understanding local culture and school culture is critical for mathematics coaches to be successful in culturally rich, international contexts.

School Cultural

A school's culture is the sum of many different variables stemming from leadership practices, faculty and staff beliefs on the nature of teaching and learning, and the values of the local community (Hill, 2014); no one variable is more important than the others. With respect to leadership, a school's culture depends on the levels of trust, respect, and autonomy the leadership team establishes in the building. A school's culture also is grounded in the internal and external influences shaping beliefs of the school and the ways in which all persons in the building interact with each other. That is, a positive school culture is based on a shared philosophy of how best to encourage and support learning (Caskova & Chudy, 2021). Although a school's mission and vision statements hint to its priorities and values, the core of this shared philosophy is in the lived, day-to-day experiences wherein the mission and vision are actualized.

The shared philosophy of teaching, learning, and long-term outcomes for students is not the only way in which a school culture is established. The local community plays an important role in establishing the culture of the school because the school is an extension of the community (Hill, 2014). In the case of international schools, shaping a school's culture also includes shared beliefs and values of the community and host nation. Likewise, a school may have a particular curricular or instructional framework around which they situate teaching and learning (e.g., using standards and curricular resources from the United States, hiring teachers exclusively with experience matching the curricular model). Despite this instructional focus, local and national cultures still impact the school's culture. Given the diversity of teaching staff in international schools and the different cultural perspectives each teacher brings to their practice (Bunnell et al., 2016), it becomes clear that the school's culture is multifaceted, creating a more complex context for instructional coaching. That is, the varied personal experiences, perspectives, and beliefs around teaching and learning mathematics may be vastly different.

Developmental Progression of Instructional Coaches

Instructional coaching is an intricate process requiring an array of different skills. Often, instructional coaches begin as highly effective teachers before transitioning into the coaching role (Chval et al., 2010). When they first begin in this position, many find the transition to be more complex and challenging than they originally expected. In turn, these challenges can lead to inaccurate and negative identities or beliefs about their ability to be a coach (Ortmann & Roehrig, 2019). Recognizing both this transition and the impact it can have on the self-efficacy of a mathematics coach is of particular importance in an international school due to the cultural richness of the students, teachers, administrators, and community because the school often becomes a surrogate family while living abroad.

Challenges for a Beginner Mathematics Coach

Becoming a mathematics coach is not always easy, and understanding the nuances of this work is not always intuitive. Transitioning from a classroom teacher to a collaborative mathematics coach can be difficult for many reasons. For example, if school leadership does not appropriately communicate the roles and responsibilities and continually support coaches (Ippolito & Bean, 2019), mathematics teachers may not understand what resources and benefits are provided through coaching. Likewise, new instructional coaches may not fully understand the differences between working with adults versus children, measuring professional success or accomplishments for teams, and otherwise adapting to responsibilities that often are ill defined or generally not understood by the larger school community (NCSM, 2019). Essentially, hidden variables may exist at an institutional level that impact the success and self-efficacy of new coaches.

Additionally, teachers sometimes resist working with coaches for several reasons. For some, it may be due to a lack of trust; for others, it may be that they are unsure how a mathematics coach can help them in the classroom, or there may be unanswered questions about whose interests the coach has in mind (Moody, 2019). Likewise, teachers may push back and scrutinize coaches for not having pedagogical knowledge across the K–12 spectrum (Hayes & Irby, 2020) or teaching experience working with a particular grade level (Rapacki & Francis, 2014). It may be difficult for an elementary teacher to accept support or feedback from a coach if the coach's teaching experience was at the secondary level and vice versa for secondary teachers. Although an effective mathematics coach will know how to work with adults in this situation to support their professional growth, the reality is that newer coaches often have limited professional experiences to help them do this well (NCSM, 2019).

Furthermore, international teachers from various cultural backgrounds interpret these interactions differently based on their own past cultural experiences (Hill, 2014). This varied interpretation means challenges experienced by new mathematics coaches when working with teachers in an international school may result from different cultural perspectives and understandings, not a lack of trust in the coach. Some international teachers may not fully understand the role and nature of instructional coaching and may unintentionally struggle to work with the mathematics coach even if they already know them well. If instructional coaching has not existed in the schools in which they previously worked, resistance may simply be because they do not understand the context of the coach and do not know which "box" the coaches belong in.

Developing Self-Efficacy as a Mathematics Coach

The potential challenges associated with starting a role as a new mathematics coach with no previous experience can have an impact on the coach's self-efficacy. Depending upon their experiences in this transition, the process can have a tremendous impact on their professional identity, perceived competencies, and self-efficacy as a teacher leader. Furthermore, this transition can be amplified when the cultural context is considered.

To help mathematics coaches develop their self-efficacy as instructional and curricular specialists, a focus is needed on understanding key shifts in their work. For example, Ortmann and Roehrig (2019) found some new coaches rely on previous identity constructs, which may not help them when working with adult learners. Attending to the needs of students and adult learners is fundamentally different; thus, how coaches support teachers is fundamentally different from how they support students (NCSM, 2019). Furthermore, if a new coach focuses primarily on teaching effectiveness, they may miss opportunities to examine other aspects of coaching, such as attending to student learning to support nonevaluative conversations around teaching (Bennett et al., 2015). However, and as previously mentioned, cross-cultural awareness is needed when working with teachers from varied cultural backgrounds (Ospina & Medina, 2020). If cross-cultural awareness remains underdeveloped, coaching teachers can become even more difficult, which can result in feelings of professional doubt and incompetence.

To develop stronger self-efficacy, mathematics coaches need to understand culturally relevant pedagogies and teaching practices (Lindsey et al., 2019). As a mathematics coach, recognizing the importance of students' cultural backgrounds in shaping their learning experiences is paramount in fostering academic success and supporting students' mathematical identities (Ladson-Billings, 1995). When teachers link classroom instruction to students' lived experiences, as reflected in the curriculum and other learning experiences, they commit to seeing and recognizing the strengths students bring to learning mathematics and thus help students believe they can be successful in learning mathematics (Thomas & Berry, 2019). As such, understanding the intersection of culture, student learning outcomes, and effective teaching practices is important for the success of mathematics coaches.

METHODS

The purpose of this study was to capture the lived experiences of one mathematics coach, new to instructional coaching, who worked in an international American curriculum school to better understand challenges they faced in systematically supporting mathematics teachers in their own work. Given the substantial role and impact of being in a new country with very different cultural and school–community norms, this study examined the cultural and professional shifts in understanding needed for a mathematics coach within a culturally diverse, non-Westernized context. Ample research has examined challenges faced by mathematics coaches in the United States (e.g. Gibbons et al., 2017; Kane & Saclarides, 2023)), but little research has examined this work in an international context, despite the sheer number of American curriculum schools globally. Thus, this study focused on understanding the human, lived experience as a mathematics coach in an international American school to understand the challenges and nuances of mathematics coaching in these culturally rich contexts.

Methodology

This study used a qualitative narrative case study design (Hussain et al., 2012) to follow the efforts of one mathematics coach and understand their lived experiences as a new mathematics coach within an international education context. This study was grounded in two primary theoretical frameworks centered on narrative research. The first framework was a means to understand non-Western ways of knowing (Overton, 2017), and the second framework entailed understanding the sociocultural impact on developing teachers (Philpott, 2014). Lived non-Westernized experiences create global perspectives and competencies relevant to growing and developing as a professional educator. A narrative design grounded in sociocultural theory was subsequently ideal for connecting and representing the lived experiences of such educators (Moen, 2006). Narrative designs, related to ethnographic approaches (Creswell, 2018), rely on multiple data sources. This study used narrative descriptions, semistructured interviews and reflections from the mathematics coach, as well as field notes and observations from the researchers collected over a 4-year period as sources of data.

Context and Participant

This study took place at The International American School (TIAS), a private American curriculum school in a small country located in the Middle East. The school was a relatively new school, having been open for approximately 10 years at the time of the study, and served students from preschool through high school. At the primary level, there were about three classrooms per grade with about 1,000 students enrolled across all primary and secondary grades. Even though TIAS was considered an American curriculum school focused on curriculum and standards in the United States, over 40 different nationalities were represented in the student body and approximately half the students were English language learners, meaning English was not their first language.

The teachers at TIAS were classified into two primary categories: lead teachers and coteachers. For the primary grades and generally for all core subjects in the middle and high schools, the lead teachers were U.S. born or had credentials from the United States along with substantial experience teaching in schools within the United States. Coteachers typically came from the Philippines, though not exclusively, but all were certified teachers with substantial experience teaching in their home countries. Although coteachers were assigned to support the primary teachers, in most instances, they simply were used as classroom aids in small group instruction settings, with little to no teaching responsibilities.

Coach Johnson came to TIAS after teaching for 10 years in the United States. He taught eighth-grade mathematics for 6 years at two separate Title I schools in a large urban area of the southeast United States wherein 90% of the student population received free or reduced lunch. He also taught eighth-grade mathematics and Algebra I in a racially and culturally diverse school where 40% of the student population received free or reduced lunch, and then he taught for 2 years at a tuition-free, public charter

school where he taught physical education and eighth-grade mathematics. Prior to transitioning from a middle school mathematics teacher to a mathematics coach at TIAS, Coach Johnson had no prior experience as an instructional coach, though he did serve as department chair and as an informal mentor to new and incoming mathematics teachers at TIAS.

Analysis

Using a case-centred approach (Bruce et al., 2016), narrative descriptions and semistructured interviews were recorded, transcribed, and then independently coded by the researchers. The codes were shared and discussed to develop common themes relating to challenges or other cultural nuances that influenced Coach Johnson's perceived success as a mathematics coach. Field notes were used to triangulate reflective narrative data and provide opportunities for further discussion between the researchers to provide clarity and context to Coach Johnson's highly personal and reflective interpretations (Deggs & Hernandez, 2018). To add a greater degree of trustworthiness, the researchers routinely discussed the findings and interpretations made from these data to ensure the findings were accurate.

FINDINGS

Findings from the data revealed several major themes relating to mathematics coaching in an international school context. Some of these themes included the challenges Coach Johnson faced in learning strategies for supporting adult learners and in helping various grade-level teams implement curricular changes. However, for this paper, two additional themes are discussed because they attended to the unique phenomena within an international context that influenced Coach Johnson's work. These additional themes centered on the intersection of the local culture and the impact it had on the classrooms he supported.

The first theme highlighted the ways in which non-Westernized cultures and perceptions of education influence how a mathematics coach engages in their work. The second theme focused on the structural challenges in the school. These challenges included issues with transient teachers and teacher leaders as well as beliefs around instructional coaching and curricular alignment when teachers used resources they brought with them from other international schools. Collectively, these challenges also impacted Coach Johnson's self-efficacy and identity as a mathematics coach.

The Intersection of Local Culture and Education

The Middle Eastern country in which TIAS resided had a rich culture based on the importance of family, status, and religion. The national government was actively engaged in promoting continuous school improvement for international schools with the government, investing substantial sums of money, but as Coach Johnson indicated, "There is little to no support for expats who lack training in grasping the impact of their cultural values and how these might impact teaching and learning mathematics." For Coach Johnson, this lack of support was a limiting factor in his professional effectiveness. He explained, "There were numerous cultural norms I did not get at first," which meant he lacked the cultural understanding for various professional interactions, often leading to awkward or uncomfortable moments in the classroom.

Family Structures and Norms

Coach Johnson also learned about common traditional family norms while at TIAS. In the host nation, family norms and traditions were quite different from what Coach Johnson originally expected or was used to experiencing in the United States. In the host nation, family structure played a major role in the daily lives of the people and was central to the culture of the community and the nation. Coach Johnson did not initially realize how family norms impacted the country's culture. He said, "[Here], family structures and traditions are based upon family cohesion, paternal authority, and pride of origin," and shared that it was common for members of the extended family, like cousins, to live in the same household during their childhood. Coach Johnson explained, "At first, this was confusing because I wasn't always sure who the parents were." Also, the family name played an important role in social and economic influence in the community; the royal family lineage and other prominent names were easily recognizable, which mattered greatly in the culture. Coach Johnson said, "A child's family name gives off an incredible amount of social information about the person," and a person's status and prestige in the community depended greatly on this family name, especially if the family was from the royal line (i.e., one of the original families that established the modern country). Coach Johnson recalled one instance where his way of working with students was not culturally appropriate at TIAS, but he was unaware of his cultural misstep. He recalled:

> *Early on, I had a class with four different students, all with the same name. I was like, "Okay, since I have four Mohammads with the same first, middle, and last names in my class, I will develop a way to distinguish you all by visual characteristics." What I didn't know was that this was a major cultural problem. I just wanted different ways to tell them apart, but family lineage is very important and can be offensive if mishandled. Even the prefix "Al-" before a name is used to mark the prominence of all the ruling clans, and I didn't know how important it was to say when calling on a student.*

In another instance of not understanding family cultural norms, Coach Johnson was in a classroom when one student wanted to know how much it would cost to get a "B" for their grade in mathematics. The teacher did not understand the cultural importance of having high grades and the extent to which families would go for students to have these high grades; deserving or not, high grades were part of the identity of local families. It was customary for families to hire external people to create dioramas for history projects; build highly detailed models for an Earth science project; or, in this case, for the student to ask for the price of a "B" because he wanted to show off his grades in mathematics and make his family proud. Coach Johnson recalled responding to the student, "$5,000!," only to have the student set their debit card on the teacher's desk and say, in all seriousness, "Just return it when you are done." Needless to say, Coach Johnson did not take the card, but it made him aware that he did not fully understand family expectations with respect to school.

At first, when Coach Johnson began working at TIAS, it was easy to think of this American curriculum school as a U.S. school; the textbooks, standards, assessments, and instructional frameworks all came from the United States. Furthermore, most teachers were from the United States. However, the local culture was not American, and not knowing cultural nuances hindered the way in which Coach Johnson developed relationships with students and families. He explained, "What expats need to understand is the massive role religion and family play in [this] society. When they do, they are able to better understand how the local culture and norms greatly impact teaching and learning." Thus, being a mathematics coach also meant attending to the intersection of religion and families' cultural norms and the influence they had in and beyond the classroom learning environment. For example, during Ramadan, some teachers would eat snacks or have their lunches out in front of the students who were fasting. Not being aware of this cultural faux pas meant the teachers were not considering the ways in which culture impacted learning. It was hard for students to think about learning mathematics when they were only thinking about the teacher's food.

Structural Challenges in International Contexts

As is often the case in instructional coaching positions, the breadth of challenges is substantial, and they are often unique to the individual context. For Coach Johnson, some challenges he faced may have been like those faced by teachers in U.S.-based schools, but many challenges he encountered also stemmed from the structural nature of international schools. Some of these challenges dealt with frequent turnover of teachers and principals, confusion around the nature of coaching, stalled efforts to create a unified curriculum, and the impact these challenges had on his self-efficacy as a mathematics coach.

Frequent Turnover

The success of coaching often begins with building relationships. However, from an international context, building relationships with teachers and people on the leadership team can be challenging because there is rather high turnover among teachers and administrators. Coach Johnson indicated teachers sometimes simply left overnight. One day he would see them in the school, only to come back the next day to learn the teacher had packed their apartment, gotten on a plane, and left the country without saying anything to anyone. Coach Johnson said, "You get started on something and you are making progress with the math teachers, and then one is just gone. How am I supposed to work with that?" Although this example was somewhat extreme, it happened more than once during his tenure at TIAS. He stated, "It just feels like you are constantly starting over sometimes."

Furthermore, teachers were not the only ones for whom there was high turnover. Principals rarely stayed long, which also made it a challenge for Coach Johnson to build working relationships with school leaders. Coach Johnson explained, "We've had more leader turnover than we've had teacher turnover; no principal has been in the job more than 2 years since I've been here." This frequent change in leadership also made it difficult for him to work with teachers. Teachers might have gone along with some of the initiatives from leadership, but they knew these initiatives would not last. He said, "Once the principals left, the teachers were like 'Well, we don't have to do that anymore,'" which created a culture that inhibited collective efforts at school improvement. Simply stated, the teachers knew, as Coach Johnson said, "If you wait long enough, it will change," which made him question the effectiveness of his work as a mathematics coach.

Confusion and Resistance to Coaching

Related to school leadership and supporting leadership structures, no previous mathematics coaching position existed at TIAS, and the school principals and teachers, many of whom had a rich history working at international schools, were not familiar with the roles and responsibilities of any kind of instructional coach, let alone a mathematics coach. Coach Johnson indicated this lack of familiarity was common in international schools based on his interactions and discussions with colleagues in other international schools and countries. He said, "When I would tell them I'm a coach, it was like, 'So you're, like, the assistant principal? Like, what do you mean? You coach basketball?'"

Furthermore, Coach Johnson indicated it was hard to connect to other school leaders and teacher leaders around coaching because the role of a mathematics coach was not well understood; he was viewed as an administrator because there was no other context or schema to which the other teachers could relate. Even regarding international job postings, he explained, "This is something that's fairly new to the international world. I don't see a lot of coaching positions." Although many international schools had coaches or people who served in "instructional support" roles, according to Coach Johnson, many more did not have such positions in their schools. Collectively, the rarity of coaching positions internationally meant his work as a mathematics coach was often misunderstood because of confusion around the nature of his role. High turnover in instructional and leadership staff also meant he had to redefine and explain his role every year.

Curriculum Alignment

Within international contexts, common curricular issues result from frequent and ongoing teacher turnover. Even with a well-developed curriculum that includes up-to-date textbooks, pacing guides, scope and sequence documents, and assessment guides, Coach Johnson explained, "Many teachers bring their own patchwork curriculum with them." Because of this structure, teachers often teach whatever they like based on what they taught at their previous school(s), creating vastly different teaching and learning experiences within and across grades. The resulting curriculum, Coach Johnson said, "was just totally discombobulated."

Furthermore, it can be common for teachers in the same grade to not only teach different content at different times throughout the year but also to use different standards from different countries, or even no standards at all, despite clear messages from leadership regarding expectations in

the school. Even though most teachers were from or were trained in the United States, Coach Johnson explained that many began their teaching careers before the adoption and implementation of the Common Core Standards for Mathematics, which meant they were unaware of how to even consider these standards in designing instruction and measuring learning outcomes. Coach Johnson explained:

> *Whatever part of the world you are from, you just kind of introduced those concepts that you are most comfortable teaching for that particular grade. So, someone in third grade, that is from a totally different country, although teaching the curriculum from Common Core, everyone was pulling from different things, different assessments across the grade levels, things of that nature.*

Even within the same grades, teachers did not align their curriculum. Coach Johnson said, "What they're doing is totally different; it's not even where they might be a week or 2 ahead. [One teacher is] in Unit 2, and another teacher is on Unit 6 because she just prefers to teach it right now." From a coaching standpoint, this curricular fragmentation created substantial challenges trying to support individual grade levels, unify the mathematics curriculum, and collectively understand effective teaching practices in mathematics across the school. Coach Johnson stated, "There's no opportunity for team building or vertical or horizontal alignment at all." At times, and in multiple elementary grades, he recalled that there were three different instructional programs, one for each teacher's classroom.

To compound issues with the varied curricular resources at the classroom level, other challenges beyond Coach Johnson's control also impacted curricular choices. Namely, teacher and administrator turnover were constant, which caused a shift in priorities as to what curricular resources and pedagogical approaches should be used to support teachers and students. Coach Johnson noted, "When I look back, it was like, okay, we did what we needed to. But then, it was like, all right, big brother is no longer watching, we can go back and do what we wanted to do." It was all but impossible to sustain academic programs and instructional initiatives with so much turnover and shifting priorities in the leadership. Coach Johnson said, "[It] is not a good thing, definitely for the kids, but for the school as well."

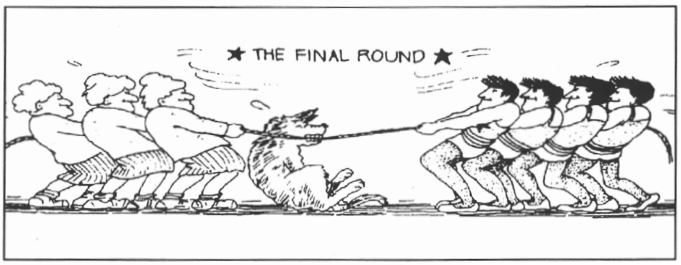
Culturally Relevant Learning Experiences

As is the case in many schools in the United States, classrooms at TIAS were culturally and linguistically rich. However, these cultural differences were rarely considered when developing lessons and selecting mathematical tasks or other explorations. For example, Coach Johnson worked with a group of secondary mathematics teachers to reduce the amount of direct instruction and lecturing during class; he wanted teachers to find ways for students to debate, create arguments, or otherwise learn to develop their reasoning through more discursive interactions.

To help secondary mathematics teachers understand what this approach might look and sound like in the classroom, Coach Johnson decided to model the process for this group of teachers. Coach Johnson met with them prior to the lesson to discuss the standards, learning objectives for the lesson, and the types of formative assessments he would use to gauge student understanding. He chose a task, a *mathematical tug-o-war* (Burns, 1996), that required substantial algebraic reasoning but without numbers or any formal symbolic representations (see Figure 1). This task showed three rounds of tug-o-war and asked students to determine who would win the final round. The first round had four acrobats against five grandmas, and this round was a draw. Round 2 had Ivan the dog against two grandmas and one acrobat, and this round also was a draw. The final round had three grandmas and the dog against four acrobats; the task was to determine which side would win. Coach Johnson even developed and shared with the teachers a set of potential mathematical misconceptions students might have and accompanying questions or probes to help them navigate their thinking without telling students what to do mathematically. What he did not consider was the role students' cultures would play in preventing them from even beginning to consider the mathematics involved.

Figure 1

The Third Round of Burns's Mathematical Tug-O-War



Note. Adapted by Keith Amano from *50 Problem-Solving Lessons: Grades 1–6* (p. X), by M. Burns, 1996. Copyright 1996 by Math Solutions Press.

With the teachers watching, Coach Johnson told students what they would be working on for the day, how it fit with what they had been learning, and how it would help them develop mathematical habits of mind and interaction. He then presented the task to the students, ready for them to dive in. In reflecting on how he felt going into the lesson, Coach Johnson said, "I was so excited to try this task because I just knew these algebra students would love it; [the task] is so accessible and creates so much discussion." What happened was not what he had anticipated.

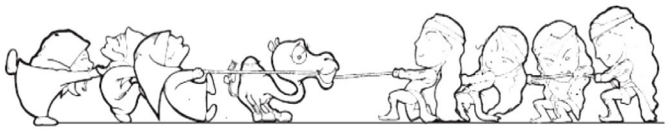
Coach Johnson told students to open Google Classroom and find the task; open it; and then, with their small group, come up with some ideas as to who would win. He also instructed them to be ready to defend their thinking; the students needed to have "because" statements for their claims as to who would win the tug-o-war. Students opened the assignment and read it, but many did not even finish the whole prompt; they were confused about Ivan the dog. Coach Johnson recalled, "My students kept asking me, 'Coach. Why is there a dog?' and I was like, 'What do you mean? It's just a dog'; I couldn't figure out why that was a problem for them." After several minutes, and after Coach Johnson checked on several groups, he stopped the class and asked them why the dog was such a big deal. One student commented, "Coach. It doesn't make any sense to have a

dog in the middle of the desert; they could die." At that point, Coach Johnson stopped the exploration and asked the regular classroom teacher to continue with the lessons from the day before; he knew the students were so stuck on the context that they could not yet consider the mathematics.

In this situation, Coach Johnson had not considered how the task he presented did not fit with the cultural context of the students' lived experiences. What seemed like a simple problem was not culturally relevant for the students; thus, it prevented them from considering the mathematics involved. From Coach Johnson's past experiences, he was unaware that such a misunderstanding could happen and had not scrutinized the accessibility of the task from a cultural standpoint. Coach Johnson commented, "This must have happened before, before I moved internationally, but it just never occurred to me that pictures could stop kids from doing math." In his discussions with the other secondary teachers, it was clear they also were confused as to why students struggled with this task. Many of the other teachers indicated it did not make sense that the dog should be the idea stopping students from exploring the mathematics; again, this sentiment was an indicator that the teachers hired by the school, who were not from the local community and did not share the same cultural perspectives, were potentially equally unprepared to consider the intersection of culture and instructional resources in learning mathematics.

To remedy this issue, an illustrator and artist was consulted to modify the illustrations to fit the local culture (see Figure 2). The grandmas remained but were drawn in attire typical of the Middle East. Ivan the dog was replaced with Omar the camel, and the acrobats were replaced with warrior princesses based on Middle Eastern historical figures.

Figure 2
Culturally Appropriate Modifications to M. Burns's Illustration



Note. Adapted by Keith Amano from *50 Problem-Solving Lessons: Grades 1–6* (p. X), by M. Burns, 1996. Copyright 1996 by Math Solutions Press.

Once the modified illustrations were completed, Coach Johnson presented the problem to the same group of students. This time, there was no discussion about the people or animals in the task, but the students engaged in rich discussions about who would win and why, with multiple means of representation from the students. Coach Johnson said, "I never thought in a million years how important it would be to have a context or drawing that was culturally appropriate"; yet, from this experience, he knew and said, "I have to always take this into consideration no matter where I am."

DISCUSSION

This study sought to capture the lived experiences of one mathematics coach, new to instructional coaching, who worked in an international American curriculum school to better understand challenges they faced in systematically supporting mathematics teachers in their own work. Despite the wealth of research and resources on instructional coaching, the study highlighted that there is still much to learn and do for schools in culturally rich contexts. This work is especially salient considering the cultural nuances in international schools (Bunnell et al., 2016).

Mathematics coaches can play a substantial role in creating meaningful change in international schools, but an understanding of the nature and complexity of cross-cultural work environments, and, in this case, the dynamics of coaching in culturally rich settings with colleagues who have equally rich, relevant, and professionally diverse backgrounds and experiences, is also critical. Ospina and Mediana (2020) outlined the importance of understanding these cultural implications and international school norms. Within a more global context, mathematics coaches are faced with challenges that may not be evident, even when school leaders have good intentions (Halicioglu, 2015). This study supported these challenges and highlighted how such an awareness may better support coaches in developing their professional skills and self-efficacy as mathematics teacher leaders.

This study also revealed areas specific to coaching internationally that should be considered. Namely, the effectiveness of mathematics coaches in international schools is minimal if their roles are not well understood across leadership teams and among teachers (Hashim, 2020; Killion et al., 2020). This ambiguity in their role can be problematic if there are no internal structures to overcome the impacts of frequent turnover in leadership roles and if coaches are not supported in learning about cultural implications of teaching and learning in the host nation. Ortmann and Roehrig (2019) and Moody (2019) have indicated that these structural issues are key to developing a mathematics coach's effectiveness, and the findings of this study supported this.

When considering the findings of this study and their relation to coaching contexts in the United States, it was not hard to see similarities. For example, developing a viable and coherent mathematics curriculum is central to the work of a mathematics coach (NCSM, 2019). This work has continued to emerge as a priority in school districts across the United States because equitable access to learning is a key pillar to student success. Likewise, when mathematics teachers do not understand local community and/or school culture (e.g., a teacher who has never lived in a highly urban area or whose race is different than most of the students they teach), they may not understand fully how to create empowering mathematical learning experiences based on their students' cultural knowledge (Seda & Brown, 2021). Across the United States, there have continued to be substantial differences in the number of teachers whose culture or race is different from the students, families, and communities they serve (Howard, 2016). For mathematics teacher leaders in the United States, this widening demographic gap should be a call to consider and reevaluate the resources, training, and perspectives their coaches have and bring to their work as they support teachers and students in culturally rich

settings. For both domestic and international schools, this persistent cultural disconnect may serve as a reminder of the importance of continually developing and revisiting practices that develop cultural competencies for mathematics teachers and teacher leaders. It is not only content knowledge or years in the classroom that matter when it comes to being an effective mathematics coach. The intersections of culture, student learning outcomes, and effective teaching practices must be recognized and purposefully navigated to support mathematics teachers systematically.

Unless a more coherent, comprehensive culturally focused approach to developing and nurturing effective mathematics coaches begins, the potential benefits of the coach may not materialize as intended. However, understanding these challenges and nuances can provide opportunities for self- and collective reflection; bridge important conversations with purposeful action; and, more broadly, help mathematics teacher leaders frame conversations around mathematics coaching in more inclusive non-Westernized contexts and ways of thinking.

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BRIDGING RESEARCH AND PRACTICE IN MATHEMATICS EDUCATION: EXPLORING DISTRICT-LEVEL MATHEMATICS SPECIALISTS' RESPONSIBILITIES AND PROFESSIONAL LEARNING NEEDS

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ABSTRACT

This exploratory study and related analysis investigated the roles, responsibilities, and professional learning needs of school district-based mathematics specialists (DMSs), who play a crucial role in shaping mathematics education. Despite the potential significance of their influence, limited research exists on what DMSs need to know to influence, support, and lead coherent instructional systems. To address this concern, our research team developed a survey to gather data on DMSs' roles and responsibilities related to professional development and curricular implementation. Findings revealed variability in DMSs' roles, involvement in professional development, influences on goal setting, and professional learning needs. Based on these findings, we offered recommendations for DMSs' implementation of district- and state-wide curriculum initiatives. These state-level insights are generalizable to other areas of the United States and highlight the vital role of DMSs in supporting and enhancing mathematics teaching and learning across school districts nationally.

Over the past 40 years, scholarship on mathematics leadership has expanded considerably (Baker et al., 2021; Herbst et al., 2021), though researchers have predominantly emphasized school-based mathematics specialists (Baker et al., 2021). Prior studies have documented how school-based mathematics specialists enact a variety of responsibilities (Mudzimiri et al., 2014), cultivate leadership identities (Chval et al., 2010), and influence classroom instruction and professional learning (Campbell et al., 2017). More recently, researchers have begun to expand this line of inquiry to the district level, examining the work of district-based mathematics specialists (DMSs; Baker et al., 2023; Herbst et al., 2021), yet the field lacks a robust understanding of how DMSs develop and apply the knowledge and practices needed to guide systemwide instructional improvement (Jackson et al., 2018).

As a primary professional organization for DMSs, the National Council of Supervisors of Mathematics (NCSM) has long recognized their critical role in shaping mathematics education. Since its founding in 1968, NCSM has provided a platform for DMSs to share ideas, address emerging challenges, and engage in ongoing study of specialized issues in the field. According to NCSM's first president, Louis Scholl (1970), one of the main aims of the National Council of Supervisors of Mathematics is to maintain an ongoing focus on examining specialized issues within mathematics education. NCSM has contributed to the development of more coherent and effective mathematics instructional systems by fostering collaboration and professional learning among district leaders. However, despite this longstanding professional recognition, empirical research on DMSs' roles, responsibilities, and professional development (PD) needs has remained limited (Bolyard & Baker, 2025).

DMSs hold pivotal positions in shaping the direction and quality of mathematics education across school systems (Burch & Spillane, 2003). Serving as critical intermediaries between a school district's administration and classroom practices (Jarry-Shore et al., 2023), DMSs lead efforts to enhance teachers' instructional practices (Hopkins et al., 2017), guide mathematics curriculum development (Munter et al., 2023; Rigby et al., 2018), and ensure alignment with state and national standards (Whitworth et al., 2017). Through this work, DMSs ensure the establishment of a "coherent instructional system at the school level" (Jackson et al., 2018, p. 193).

Building on the emerging field of DMS research (Munter et al., 2023), this paper presented an exploratory investigation into the responsibilities and needs of DMSs. The study also considered how DMSs address these responsibilities themselves. The inquiry was guided by a series of wonderings designed to assess both current practices and PD needs of district mathematics leaders in the state of Virginia: (a) What are the roles and responsibilities of DMSs in Virginia? (b) How are these related to goals and instructional needs of school districts and schools? (c) How are DMSs engaged in state-, district-, and school-level change? and (d) What are the professional learning needs of DMSs? In the following sections, we provide background literature on DMSs, detail our exploratory research approach, and explain the intent behind our survey instrument, shedding light on key factors shaping the work of these critical education leaders.

CONCEPTUAL FRAMING: THE NEED FOR GREATER CLARITY ON DMS

Despite broad recognition of the impact district-based mathematics leaders have on improving mathematics teaching and learning, DMSs have received limited attention in literature (Baker et al., 2023; Lochmiller, 2015). Existing work on district leadership conceptualized it "as a generic enterprise" (Stein & D'Amico, 2000, p. 1) despite the recognition that content specificity matters in instructional improvement efforts. Further, researchers have generally overlooked the specialized role of DMSs (Baker et al., 2021), focusing instead on other educational leadership positions (e.g., superintendents, principals; Herbst et al., 2021). In fact, Jackson et al. (2018) emphasized, "The existing research was thin with regard to what central office leaders need to know and do in order to support the development of coherent instructional systems" (p. 194). Such a gap underscores the need to explore how DMSs can be supported and how their leadership advances ambitious, equitable mathematics instruction (Lampert et al., 2011). Understanding DMSs' contexts, roles, and responsibilities—and how they facilitate instructional improvement across districts—is critical for informing research, policy, and practice.

The following sections situate DMSs in the existing literature, highlighting what is known about their roles, responsibilities, and challenges while identifying key gaps warranting further study. To guide readers, we organized the conceptual framing into three interrelated areas: (a) knowledge limitations in DMS research, (b) variability in DMS contexts, and (c) core DMS roles and responsibilities. Together, these three areas provide a comprehensive lens for understanding DMS work; variability and knowledge limitations frame the challenges and constraints DMSs face, and core roles and responsibilities illustrate how they act in those contexts. Examining these areas in tandem allowed for a more nuanced understanding of the complexities of DMS leadership and identified where future research and practice can better support the work of the DMS in advancing equitable, high-quality mathematics instruction.

Knowledge Limitations in DMS Research

For close to 4 decades, a great deal of research has focused on ways superintendents (Liang et al., 2020; Murphy & Hallinger, 1986); principals (Lee & Lee, 2020; Manasse, 1985); and, to a lesser extent, school district offices (Mac Iver et al., 2019) lead instructional improvement efforts. Research on superintendents has examined a wide variety of dynamics, including the impact of reform and accountability agendas on their work (Bredeson & Kose, 2007) and how they set instructional goals (Nino et al., 2018) and self-identify professional learning needs (Spanneut et al., 2011). Educator preparation scholars have engaged in a similarly wide variety of research surrounding the work of principals, such as their PD needs (Foley, 2001), development of instructional goals (Lee & Lee, 2020), and preparedness to implement culturally responsive school leadership (Holmes & Hope, 2023). Despite this extensive research on other district- and school-level leaders, DMSs have remained largely overlooked. Although DMSs are influential to the success and sustainability of mathematics reform initiatives, rarely have researchers captured their insights or perspectives as part of systemic change efforts or content specialists in district leadership (Hjalmarson & Baker, 2020). Of 130 articles identified in a recent research synthesis on mathematics specialists broadly (Baker et al., 2021), only eight articles (5%) published between 1981 and 2021 mentioned DMSs. This number only captured the quantity of articles that mentioned DMSs; it did not speak to the DMSs' responsibilities and impact described in the articles. Such paltry representation of DMSs in research is paralleled in existing standards for their preparation.

National organizations have published standards for the preparation of PreK–12 teachers (Association of Mathematics Teacher Educators [AMTE], 2017) and school-level mathematics specialists (AMTE, 2024). We also identified a recently revised joint position statement that advocated for K–6 mathematics specialists (AMTE, Association of State Supervisors of Mathematics, NCSM, & National Council of Teachers of Mathematics [NCTM], 2022) to ensure equitable and effective mathematics learning opportunities in the classroom. However, no such preparation standards or position statements exist that have addressed and supported the preparation, importance, and impact of DMSs. This oversight has resulted in a limited knowledge base of what DMSs need to know and do to lead and support the development of coherent instructional systems focused on mathematics (Jackson et al., 2018).

Variability in DMS Contexts

If the field of mathematics education is to consider how to bring ambitious mathematics teaching (Lampert et al., 2011) and learning to scale (Cobb et al., 2018), it is essential to study the work of DMSs because these individuals have significant influence over the teaching and learning of mathematics (Baker et al., 2022; Jackson et al., 2018). DMSs work to make instructional changes within school systems that are subject to the influence of political, fiscal, and social changes; policy changes; long-established school structures; and conflicting ideas about the purpose of schooling and approaches to improving instruction (Jackson et al., 2018; Shields et al., 1999). To support DMSs to both envision and enact mathematics improvement efforts, it is essential to understand how DMSs make sense of, plan for, and enact instructional reform (Burch & Spillane, 2003) to influence PreK–12 mathematics teaching and learning at scale (Jackson et al., 2018).

Despite their critical role in supporting mathematics instruction, the position of DMSs lacks consistent definition, with substantial variation in titles (Greenes, 2013) across districts and states (Baker et al., 2022; Bolyard & Baker, 2025). Titles range from mathematics-specific designations (e.g., mathematics supervisor, mathematics coordinator) to broader labels (e.g., instructional specialist, STEM coordinator). This inconsistency, coupled with ambiguity regarding responsibilities (Munter et al., 2023), obscures understanding of both the scope of role and types of support DMSs need (Bolyard & Baker, 2025). Such variability complicates efforts to define and study the position and can

hinder DMSs' abilities to enact content-specific leadership effectively (Greenes, 2013; Obara & Sloan, 2009). To advance mathematics improvement efforts, it is essential to examine how these inconsistencies influence DMSs' work and the support they need for curriculum development, instructional leadership, and professional learning.

Clarifying the contextual nature of DMS leadership in research is particularly important because these positions shape the design and enactment of ambitious, equitable mathematics instruction directly. As noted previously, given the wide variation in DMS titles (Greenes, 2013) and responsibilities (Munter et al., 2023), research and practice must clearly articulate the contextual differences of the DMS position to better understand and define these distinctions (Baker et al., 2021). Consequently, the field should investigate how DMSs develop the content-specific knowledge, skills, and dispositions required to lead instructional improvement efforts (Jackson et al., 2018) because these aspects remain largely unexplored (Bolyard & Baker, 2025).

Core DMSs Roles and Responsibilities

The role of a DMS is complex and demanding (Bolyard & Baker, 2025) because these leaders play a critical role in advancing PreK–12 mathematics teaching and learning in a school district (National Academies of Sciences, Engineering, and Medicine, 2024; Munter et al., 2023). As school systems strive to improve mathematics outcomes, DMS responsibilities have expanded beyond classroom instruction to broader leadership functions that shape district-wide improvement. Jackson et al. (2018) emphasized that the primary aim of district-level instructional leadership is to "support the development of coherent instructional systems at the school level, thereby building school-level capacity for instructional improvement" (p. 193). Achieving this vision requires DMSs to have expertise in implementing ambitious instruction (Lampert et al., 2011), strengthening teachers' content knowledge through professional learning (Hopkins et al., 2017; Jarry-Shore et al., 2023; Stein & Coburn, 2008), and creating coherent instructional systems (Cobb et al., 2018; Jackson et al., 2018). Although little consensus exists regarding the ways DMSs accomplish these goals, they typically foster the integration of research-informed teaching practices (NCTM, 2024), design and facilitate teacher (Jackson et al., 2018) and school-based mathematics specialist professional learning (Kochmanski et al., 2025), and ensure alignment between district and state policies and priorities (Cobb et al., 2018; Jackson et al., 2018).

Another core responsibility of DMSs is to develop cohesive instructional systems that enhance instructional capacity and improve student engagement and achievement in mathematics (Conference Board of the Mathematical Sciences, 2012; Jackson et al., 2018). How DMSs approach this work is shaped largely by contextual features like DMSs' orientation to improving instruction (Jackson et al., 2018), the strategic vision and priorities of the district (Baker & Knapp, 2023), the size of the district and number of schools they serve (Munter et al., 2023), and the PreK–12 stakeholders with whom they work. DMSs set short- and long-term mathematics goals; collaborate with mathematics coaches, specialists, and principals on school-based initiatives; and work with administrative teams to define their district's vision for mathematics teaching and learning (Fennell, 2018; National Academies of Sciences, Engineering, and Medicine, 2024). Effective DMSs craft a vision for high-quality mathematics instruction, establish clear goals for realizing that vision, and implement practices that are responsive to the needs of their districts (Cobb et al., 2018; Jackson et al., 2018). Yet, the limited extant research has provided little guidance on how DMSs can best accomplish these complex goals (Herbst et al., 2021; Lochmiller, 2015).

Closely linked to this leadership role, DMSs develop and align rigorous, research-based mathematics curricula across diverse classrooms, regularly updating pacing guides, materials, and instructional resources to reflect current research, best practices, and changes in district or state standards (Fennell, 2018). Cobb et al. (2018) emphasized that in districts where instructional decision making occurs largely at the school level, DMSs ensure schools have access to expertise for supporting ambitious (Lampert et al., 2011) and equitable instructional practices (NCTM, 2024). In this context, DMSs play a critical role in establishing a coherent mathematics curriculum framework and facilitating curricular integration, creating a unified approach to mathematics instruction across the district (Greenes, 2013).

Supporting teachers to improve student outcomes is central to the DMS role, ensuring the district's mathematics curriculum aligns with both state standards and broader educational goals. Fennell (2018) noted that curriculum writing and review at the PreK–12 level requires ongoing communication in the district regarding mathematics instructional issues. Munter et al. (2023) posited that district leaders often focus on student outcomes, particularly those reflected in state standardized test scores, as the most pressing challenge, with less attention paid to equity or student experiences—a focus that reflects the current accountability climate in U.S. public education. DMSs use data from formal and informal assessments to guide instruction, target interventions, and ensure equitable access to mathematics learning for all students (Greenes, 2013). DMSs also oversee district-wide communications related to mathematics instruction, conduct formal and informal teacher observations and evaluations, contribute to curriculum development and review, and manage the mathematics program budget to ensure effective allocation of resources (Fennell, 2018).

DMSs play a crucial role in cultivating professional and relational networks that extend across districts and communities (Fennell et al., 2013; Hopkins et al., 2017). By partnering with mathematics coaches, school leaders, and families, DMSs help create inclusive learning environments that promote student success in mathematics (Rigby et al., 2018, 2020; Stephan et al., 2025). They also equip families with tools and resources to support student learning outside of school, strengthening the overall support system for students' education. These networks enable DMSs to bridge organizational boundaries, enhancing collaboration and extending resources for schools (Stephan et al., 2025; Trujillo, 2013). In these collaborative efforts, DMSs work closely with

teachers and school leaders to refine instructional practices, share expertise, and build capacity to address diverse student needs (Stein & Coburn, 2008). DMSs are also integral to the development and delivery of PD opportunities, offering coaching, feedback, and personalized learning experiences to help teachers enhance their instructional strategies. These offerings can include leading workshops, organizing collaborative planning sessions, and integrating new pedagogical techniques or technologies into mathematics instruction. Both formal and informal observations of teachers (Fennell, 2018) also contribute to this continuous professional growth. The role of a DMS requires specialized knowledge and skills to support collective efforts that lead to the ongoing improvement of PreK–12 mathematics education (Hjalmarson & Baker, 2020).

METHODS

The purpose of this exploratory study and related analysis was to better understand the roles, responsibilities, and professional learning needs of DMSs, particularly as they related to PD and curricular implementation. Our survey design, distribution, and analyses are described as follows.

Survey Design

Given the importance of this exploratory investigation and recognizing the absence of an existing survey instrument aligned with our research goals, we developed our own survey instrument by drawing from a range of existing surveys to meet our needs. Our survey drew on existing research and included a combination of categorical, Likert-type, and multiple-response items (see Appendix A). The survey began with 10 items focused on gathering background information about respondents (e.g., location, licensure, role) and six open-response questions aimed at exploring the goals, needs, and challenges of DMSs (adapted from Baker et al., 2021). We also included the following items adapted from the Middle-School Mathematics and the Institutional Setting of Teaching (MIST, n.d.) Coach Survey: eight items addressing the extent to which respondents support mathematics teachers (e.g., providing professional learning), two items centered on the expectations of supervisors and principals, six items focused on DMS professional learning needs, and three items exploring the structure of leadership in the school districts' mathematics networks. We selected this survey to adapt because it was designed to capture the kinds of activities in which we were interested (i.e., activities related to documenting the goals and professional experiences of the DMSs). The survey's multifaceted focus allowed us to gather comprehensive data from participants regarding their roles and the broader context of their work while leveraging existing data collection tools. We anticipated our survey would take approximately 15–20 minutes to complete and seven open-ended questions at the end of the survey questions at the end of the survey. The survey was administered December 2023 through January 2024.

Survey Distribution

The Qualtrics online survey (see Appendix A) was distributed electronically through the Virginia Council of Supervisors of Mathematics (XCSM) listserv, which reached a broad network of district-based mathematics leaders across various educational settings in Virginia. Additionally, as a secondary distribution channel, the survey was shared directly in our state network of DMSs, further broadening the reach of potential participants. These recruitment strategies were designed to elicit prompt responses from DMSs while leveraging an organization with direct access to mathematics leadership personnel across districts. Participants were not compensated for their responses.

Participant Eligibility and Role Definitions

To define the DMS participants for this study, we drew on past research (Bolyard & Baker, 2025) in which the term "district-level mathematics specialist" was used to describe "individuals in formal leadership positions at a school district central office tasked with improving K–12 mathematics teaching and learning across [multiple] schools" (p. 2). Drawing on this work, we defined DMS as an educator employed at the district level with responsibilities including curriculum alignment, instructional coaching, PD, and data-informed decision making for mathematics programs. Participants were included if they (a) self-identified as DMSs, (b) occupied a mathematics leadership position at the district level rather than a school-based position, and (c) had a job title indicating district-level mathematics responsibilities (e.g., curriculum specialist for mathematics, mathematics coordinator). Individuals were excluded if their responsibilities were limited to classroom teaching or school-based coaching without district-wide responsibilities.

Fifty-eight survey responses were received, of which 34 were from DMSs. To ensure alignment with this study's goals, responses from non-DMS participants (e.g., school-based mathematics coaches) were excluded from the analysis. Of the 34 DMS responses, four were incomplete and were excluded to ensure only fully completed surveys were analyzed. This approach resulted in a final data set of 30 complete DMS responses. Participant characteristics are reported in the Results section. Although this sample size was relatively small for a survey study, the research was exploratory in nature, and the resulting analysis offered valuable insights that can inform future studies and guide further investigation into district-level mathematics leadership and DMS practice.

Data Analysis

We employed multiple analyses to interpret the responses to survey items connected to DMS responsibilities. Whereas the quantitative analysis of Survey Parts I–IV provided a descriptive understanding of the DMSs' context, responsibilities, and activities, the qualitative analysis of Survey Part V captured DMSs' goals, challenges, and instructional needs. Early exploration of the quantitative data informed the direction of the qualitative analysis. The two analyses were brought together to understand the themes, particularly the emergence of leadership knowledge and skills, that emerged.

Quantitative Analysis

Given the exploratory nature of this study and the small sample size (n = 30), it was not appropriate to conduct

inferential or major statistical analyses. Instead, the analysis focused on descriptive statistics and simple-group comparisons that were exploratory in nature to summarize response patterns. This approach allowed our analysis to focus on describing trends rather than generalizing to a broader population. The quantitative analysis was conducted based on four distinct sections of the survey (Parts I–IV), each corresponding to a set of survey items with different types of response formats.

Part I (i.e., Items 1–10) gathered background information about participants, including professional titles, grade bands supported, regional affiliations, and years of experience. These items were analyzed using categorical data analysis, with frequencies and percentages used to summarize the distribution of responses across these categories. Part II (Items 11–20) explored participants' professional responsibilities in their districts. Because this section included both categorical and Likert-type questions, descriptive statistics were applied with frequencies and percentages used to highlight patterns in how participants understood and enacted their professional roles. Part III (Items 21–26) examined participants' engagement in and perceptions of professional learning related to mathematics instruction and leadership. This section consisted of categorical, Likert-type, and multiple-response categorical questions. Descriptive analysis using frequencies and percentages captured the extent and nature of participants' professional learning experiences, opportunities, and supports. Finally, Part IV (Items 27–29) focused on the implementation of district mathematics initiatives, identifying the leadership roles (e.g., classroom teachers, mathematics lead teachers, coaches, administrators) most involved in supporting these initiatives in elementary schools. These multiple-response categorical questions were analyzed by counting frequencies and calculating percentages for each category, facilitating the identification of the leadership roles most frequently engaged in supporting district initiatives.

Qualitative Analysis

The analysis of open-ended responses began with hard-copy coding by our research team. An in vivo coding approach (Saldaña, 2021) was employed to honor and preserve participants' own language, ensuring codes reflected what respondents deemed important (Strauss, 1987). Initial codes included examples (e.g., supporting teachers, creating curriculum materials, providing PD). Each response was coded line by line, and our team independently reviewed and applied codes to enhance reliability. To establish coding agreement, we compared independent coding results, discussed discrepancies, and resolved differences through consensus. When necessary, we refined or merged codes to ensure conceptual clarity. Codes were subsequently grouped into broader categories and preliminary themes based on conceptual similarity and frequency. For example, codes related to DMS goal setting (e.g., district and state alignment, PD planning), challenges (e.g., shifting expectations, variability in responsibilities), and instructional needs (e.g., active participation in professional learning, research-informed materials) were clustered to form coherent thematic categories. Final themes (e.g., roles, influences on goal setting, professional learning needs) were selected based on the salience of ideas across participants, coherence in categories, and alignment with the study's research questions.

RESULTS

This section presents the key results of our exploratory investigation into the roles and responsibilities of DMSs. Our analysis revealed how these DMS participants engaged with mathematics instruction, PD, and curriculum implementation across districts in Virginia.

We first provide a descriptive overview of DMSs' roles and context. We then examine the responsibilities and challenges of DMSs, highlighting the ways DMSs facilitate PD and support mathematics teaching and learning. Next, we explore the influences on DMS goal setting, including factors guiding their planning and decision making at the time of the survey. Finally, we considered professional learning needs and support for DMSs, focusing on both sources of advice and informal support and their participation in PD. Together, these sections offered a nuanced understanding of the complexities DMSs face in shaping and sustaining effective mathematics instruction at the district level.

Because DMSs represent a relatively small professional population compared to other educator groups (e.g., principals, teachers, school-based instructional coaches), the data are presented with careful attention to protecting respondent anonymity. At the same time, key findings are shared transparently to inform understanding of DMSs as a phenomenon and to contribute to advancing the field of mathematics leadership.

Descriptive Overview of DMSs' Roles and Context

Survey respondents represented 6 of 8 regions in the state and a variety of locales (see Table 1) with DMS positions varying widely in both title and scope. Some positions were content specific, with titles such as "administrator of mathematics" or "mathematics coordinator," and others spanned multiple content areas (e.g., "supervisor of mathematics, science and other programs," "instructional coordinator," "mathematics coordinator and division director of testing"). Nearly half the respondent positions (n = 14, 47%) supported mathematics across multiple grade bands, with the remaining respondents evenly split between early childhood and elementary positions (n = 8, 27%) and middle and high school positions (n = 8, 27%). Regarding longevity in a DMS position, survey participants represented a relatively inexperienced group of DMSs. Among the 30 respondents, years of experience ranged from 1–20+, with 20+ being an outlier. The mode was 2 years, and the median was 3 years. When asked about the number of schools they supported, DMSs reported a range from a small number of schools (< 5) to many schools (> 50), with a mean of 16.2, a mode of 2, and a median of 9. Notably, two thirds of the 30 respondents indicated they were credentialed as mathematics specialists by the state of Virginia.

Table 1
DMS Overview by Focus, Regions, Locales, Number of Participants, and Selected Titles

Grade band focus	Regions (1–8)	Locales	Participants (*n*)	Selected titles
PreK–12 or PreK–8	1, 2, 3, 4, 5, 6	City, rural, suburb	14	Administrator of mathematics; mathematics learning and school support specialist; coordinator of mathematics; supervisor of mathematics; supervisor of mathematics, science, and other programs; teacher specialist for mathematics
PreK/elementary (early childhood and elementary schools)	1, 2, 3, 4	City, rural, suburb, town	8	Instructional coordinator, instructional mathematics coach, mathematics coordinator, mathematics instructional specialist, mathematics specialist
Secondary (middle and/or high schools)	1, 3, 4, 5	City, rural, suburb, town	8	Mathematics coordinator, mathematics coordinator and division director of testing, mathematics specialist, supervisor of curriculum and instruction, supervisor of mathematics, PD specialist

Note. Locale information from "Locale Boundaries," by the National Center for Education Statistics, n.d. (https://nces.ed.gov/programs/edge/geographic/localeboundaries).

Responsibilities and Challenges of DMSs
Broadly, respondents indicated that they perceived supervisors and principals as emphasizing several key aspects of their roles. Most notably, DMSs reported that these leaders expected them to "lead professional development for mathematics teachers" (supervisors $n = 29$, 97%; principals $n = 27$, 90%), "interpret and support implementation of district or state mathematics standards" (supervisors $n = 28$, 93%; principals $n = 30$, 100%), and "model or demonstrate effective teaching practices" (supervisors $n = 27$, 90%; principals $n = 25$, 83%). These perceived expectations highlighted the central role of DMSs in translating district-level vision and policies into classroom practice and supporting teacher learning.

The following sections highlight DMSs' roles, responsibilities, and challenges. Respondents emphasized their central roles in supporting teachers, implementing curriculum, and translating district-level mathematics initiatives into classroom practice.

Supporting Teachers and Curriculum Implementation
DMS participants' primary focus centered on addressing teachers' instructional needs alongside curriculum planning, with most ($n = 24$, 80%) emphasizing their responsibility in supporting teachers' transitions to revised mathematics standards. Many DMSs ($n = 25$, 83%) also spoke of the desire to shift instruction toward more student- or problem-centered approaches to teaching because there were clear interests in students' learning (e.g., "developing mathematical knowledge," "supporting student fluency") and engagement with mathematics (e.g., "improve student love for mathematics"). The instructional needs identified by participants' responses were centered primarily on accelerated changes in standards, particularly rapid shifts in mathematical expectations. Participants emphasized helping teachers use district curriculum or pacing guides ($n = 30$, 100%) and aligning instruction with mathematics standards ($n = 28$, 93%). Many also focused on helping teachers understand why certain mathematical concepts were challenging for students ($n = 28$, 93%).

An important component of DMSs' responsibilities is visiting teachers' classrooms. These visits have a primarily formative purpose, designed to support DMSs in their work with teachers. Most respondents indicated the main goal of classroom visits was to gain a greater understanding of mathematics teaching and learning in the school ($n = 29$, 97%). In fact, there was a notably limited focus on the purpose of classroom visits for classroom management and student behavior ($n = 5$, 17%). Respondents' focus was how to bring a district- or state-level vision of mathematics instruction to life in the classroom by, as one PreK mathematics curriculum specialist described, "creating scope and sequence guides for new standards."

Challenges and Resource Needs
Respondents' challenges emphasized the dual responsibility of rapidly analyzing new standards while supporting classroom teachers with implementation. At the same time, they emphasized the importance of addressing structural changes at the district level. A respondent who worked as a PreK–12 instructional specialist explained:

> *Given both the upheaval of leadership at the district and changes due to implementation of new math standards,*

[my goals] are to support and advocate for teachers and students while preparing for standards implementation and trying to help new building- and district-administrators with structures to support the teaching and learning of mathematics.

This dual focus on teacher support and district-level structural changes reflected the challenges posed by leadership upheaval and the implementation of the newly revised mathematics standards.

Further, DMSs expressed the need for both material resources (e.g., funding, curriculum materials, manipulatives) and personnel support (e.g., additional teachers, professional learning opportunities, instructional coaches). Many DMSs discussed the need for creating "documents/activities updated for the new standards," as one secondary mathematics coordinator described, and "released test items to support teachers in understanding the [new standards'] rigor," as a PreK–12 mathematics specialist mentioned. Participants aimed to streamline processes and provide high-quality resources. One PreK/elementary mathematics instructional specialist described this approach as "aligned with the new curriculum" that another PreK–12 mathematics interventionist hoped "teachers can pull from instead of from [commercial resource deleted]." A PreK–12 administrator of mathematics hoped providing these resources would allow "time and space for educator learning," and a PreK–6 mathematics coordinator mentioned providing opportunities for "mentor and coaching support for teachers in mathematics instruction."

DMSs reported several challenges. Half the respondents (n = 15, 50%) discussed the need to build teachers' and principals' mathematical content and pedagogical knowledge, and others spoke to the challenges of time constraints (n = 16, 53%) and teachers' reluctance to change (n = 7, 23%). Nine respondents (30%) identified challenges stemming from district organizational structures (e.g., being the only district-level staff member responsible for mathematics improvement, managing responsibilities across multiple schools, adapting to a new role). Overall, these findings underscored DMSs' responsibility to balance curriculum implementation, teacher support, and district-level structural changes, navigating both logistical and instructional challenges while building capacity and preparing teachers and administrators to support effective mathematics instruction.

Influences on DMS Goal Setting

DMSs' goal setting was influenced by a combination of students' learning needs (e.g., "success of students"), teacher input and feedback (e.g., "[school-level] mathematics specialists and teachers"), and guidance from leadership (e.g., "principals and their goals for their staff") and supervisors (e.g., "the chief academic officer"). Of the 30 responses, 20 (67%) articulated goals shaped by division goals, initiatives, or data trends, and 18 (60%) articulated goals related to mathematics curriculum. About half (n = 14, 47%) indicated local, regional, or state policy issues (e.g., newly revised mathematics standards) and nearly one third (n = 8, 27%) indicated current research on mathematics teaching and learning influenced their goal setting.

Overall, these responses suggested planning for district-level, long-term mathematics goals is focused primarily on supporting teachers' understanding and implementation of standards-based instruction to enhance student learning. In setting these goals, participants appeared to balance multiple influences, including district leadership priorities and strategic initiatives (e.g., division goals, supervisor guidance); contextual insights from classroom observations and interactions with teachers and students; and their own professional knowledge, experience, and research-informed beliefs. Many respondents highlighted the importance of aligning goals with state standards and policy mandates while also responding to the needs of teachers and students in their schools. Taken together, these influences underscored the complex, multifaceted nature of DMS goal setting, which integrates top-down directives, local contextual factors, and the professional judgment of mathematics leaders.

Professional Learning and Support for DMSs

To understand how DMSs develop and maintain their professional expertise, it was important to consider both the informal and formal supports upon which they rely. The following subsections explored these supports, beginning with the sources of advice and guidance participants sought in their day-to-day work and followed by their participation in PD and the topics they prioritized for further learning. Together, these findings illuminated the ways participants accessed knowledge, collaborated with colleagues, and enhanced their instructional leadership.

Sources of Advice and Informal Support

The survey asked the DMS participants to identify to whom they turned for advice. Eighteen respondents (60%) indicated a mathematics supervisor, coordinator, specialist, or coach was their first choice for such advice. When asked to list up to three contacts upon whom they relied, four respondents (13%) included a principal or assistant principal, and 18 respondents (60%) mentioned an outside consultant (e.g., colleagues from other school districts). Interestingly, only two respondents (7%) cited a professional organization (e.g., NCSM, NCTM) as one of their top three sources of advice. Regarding the type of advice sought, participants most frequently reported guidance on lesson materials (n = 16, 53%), sharing activities or instructional resources (n = 18, 60%), and discussing instructional pacing for lessons or topics (n = 20, 67%).

Participation in PD

Among the additional research needs related to the responsibilities of DMSs is the need for their own ongoing professional learning (Baker et al., 2022; Cobb et al., 2018). Needless to say, access to PD is important. Survey respondents were asked to indicate how much time (in hours) they had spent as a participant in PD workshops or seminars in mathematics, mathematics education, or mathematics instructional coaching. Most respondents reported spending 16–35 hours (n = 10, 33%) or more

than 35 hours (n = 9, 30%) as a participant in such PD opportunities during the 2023–2024 school year. Four respondents (13%) participated in PD workshops or seminars in mathematics, mathematics education, or mathematics instructional coaching lasting less than 6 hours, and two respondents (7%) did not participate in any PD workshops or seminars.

Our survey included an item that led participating DMS respondents to consider "the extent to which they would like to receive professional development (PD)" in 18 different topics. In analyzing survey responses to the PD opportunities, we found the following opportunities received the most interest, defined in this study as 20 or more of the 30 respondents (66.6% or more) indicating a response of "a lot" or "a great deal" of interest in receiving PD on these topics (see Table 2).

Table 2
Most Interested DMS PD Topics

PD topic	*f* (%)
Current research on mathematics teaching and learning	21 (70%)
Strategies to engage all students in challenging, problem-solving tasks	21 (70%)
Designing challenging, problem-solving mathematics lessons with teachers	20 (67%)

Note. Questions taken from *Coach Survey,* by MIST, n.d. Peabody College, Vanderbilt University (https://peabody.vanderbilt.edu/academics/departments/teaching-learning/mist/instrument/).

These more popular PD opportunities included topics reflecting interest in research, reasoning, professional development, and mathematics content and pedagogy. We also recognized that when determining their levels of interest in the proposed PD opportunities, one third to one half of the 30 respondents indicated several of the PD opportunities were either of little interest to them, or they were not at all interested in these opportunities (see Table 3).

Table 3
Least Interested DMS PD Topics

PD topic	*f* (%)
Aligning state standards to the adopted mathematics textbook	15 (50%)
Theories of teacher (or adult) learning	13 (43%)
Supporting mathematics teachers in using the adopted curriculum	13 (43%)

Note. Questions taken from *Coach Survey,* by MIST, n.d. Peabody College, Vanderbilt University (https://peabody.vanderbilt.edu/academics/departments/teaching-learning/mist/instrument/).

These less popular PD opportunities reflected topics that respondents indicated having little or no interest in as professional learning opportunities and ranged from aligning state standards to the district's adopted mathematics textbook, the latter of which was the least popular PD opportunity. The less popular offerings also included, in addition to those noted previously, conducting small-group meetings to support instructional practices, understanding central mathematics ideas in the adopted curriculum, and modeling instruction for mathematics teachers.

Given the reality of limited daily contact with other DMS professionals as they engage in meeting the demands of their positions, research examining ways to provide regular access to PD opportunities that include time to interact with colleagues and address specific and important professional learning needs of DMS professionals must be considered.

DISCUSSION AND IMPLICATIONS

This exploratory study examined the roles, responsibilities, and professional learning needs of DMSs, particularly in relation to PD and curricular implementation. Its generalizability was constrained by several factors. The study was conducted in a single state with a small sample (n = 30). Diversity in respondents' roles (Greenes, 2013), responsibilities (Bolyard & Baker, 2025; Munter et al., 2023), and district locales may have influenced results. In addition, the sample likely excluded DMSs outside the professional organization through which the survey was distributed, potentially skewing perspectives toward those with organizational involvement.

However, we hypothesize that these findings on DMS roles, responsibilities, and professional learning needs may generalize to other regions or states, especially because the research surrounding DMSs has remained limited (Jackson et al., 2018; Lochmiller, 2015; Munter et al., 2023). All DMSs in this study were navigating recently revised mathematics standards and emphasized their central role in supporting teachers, implementing the mathematics curriculum, and translating district initiatives into classroom instructional practice. This finding aligned with prior research showing DMSs often encounter similar challenges during curricular transitions (Jarry-Shore et al., 2023), particularly when such transitions occur at the state level (Munter et al., 2023). The following sections examine these findings in greater detail, focusing on DMSs as system-level support leaders, their roles in promoting curriculum coherence during change, and their professional learning needs and opportunities.

DMSs as System-Level Support Leaders

The role of a DMS is complex and multifaceted (Bolyard & Baker, 2025) and is central to advancing PreK–12 mathematics teaching and learning in a school district (National Academies of Sciences, Engineering, and Medicine, 2024; Munter et al., 2023). Our findings, consistent with emerging research (Bolyard & Baker, 2025), indicated that participants described a broad set of responsibilities that directly or indirectly support PreK–12 teachers despite the lack of a uniform title for the DMS role. This diversity in titles and responsibilities reflects variation in district structures but can also complicate efforts to streamline resources and provide targeted professional learning for both DMSs and the educators they serve.

Consistent with previous research (Jackson et al., 2018; Kochmanski et al., 2025), DMSs in Virginia reported engaging in extensive work to support teachers, administrators, and broader educational communities. Their support extended well beyond classroom instruction: Participants described regularly collaborating with school-based and district administrators, communicating instructional expectations, interpreting policy, and guiding decisions related to mathematics curriculum and instruction. Through these activities, DMSs contribute to building coherent instructional systems and ensuring alignment between district and state priorities (Cobb et al., 2018; Jackson et al., 2018).

Participants also emphasized the importance of monitoring, documenting, and communicating the impact of their work—often through formal reporting to district leadership—to ensure their contributions were both visible and understood. Such communication is essential for maintaining ongoing support and for helping other district leaders recognize the scope and value of DMS responsibilities. Collectively, these activities highlighted the DMSs' critical roles in the districts' instructional infrastructure and their influence on a wide range of PreK–12 constituents, including students, families, community members, and local boards of education.

As districts continue to rely on DMSs for wide-ranging instructional and organizational support, it becomes essential to understand how these professionals allocate their time and what forms of support they provide to teachers, administrators, students, families, and community stakeholders. Their work often includes preparing and delivering professional learning, collaborating with mathematics specialists and department chairs, coplanning with teachers, and reviewing or analyzing curriculum materials. Yet, despite the centrality of these responsibilities, research on DMS roles has remained limited. Important questions persist: Who becomes a DMS? How are they appointed? How do they set short- and long-term goals? What is their typical tenure? Additionally, many DMSs assume responsibilities not highlighted often in the literature nor in our survey responses (e.g., formally observing and supervising mathematics teachers, managing district mathematics budgets). These duties can occupy substantial portions of their workweeks and raise further questions about the preparation, support, and resources DMSs receive to perform them effectively.

DMS Roles in Curriculum Change and System Coherence

In our exploratory study, DMS participants reported responsibility for advancing both short-term district goals (e.g., supporting revised mathematics standards implementation) and longer term priorities (e.g., implementing research-informed practices). Their survey responses showed how the state's newly revised mathematics standards shaped their daily work, reinforcing prior findings on the challenges of maintaining coherence during curricular change (Cobb et al., 2018). During this statewide transition, DMS participants concentrated on securing and vetting the resources teachers needed to implement the newly revised standards. Despite differing district budgets, participants noted similar instructional needs across contexts and stressed the importance of providing foundational tools (e.g., pacing guides, aligned lesson plans, coherent materials) before deeper instructional work could occur. In the absence of district-vetted resources, teachers may turn to external platforms such as Teachers Pay Teachers (n.d.), which can be misaligned with district expectations. This finding further illustrates the central role of DMSs in interpreting standards and translating them into usable instructional guidance (Clements, 2007; Jackson et al., 2018).

Participants also highlighted broader tensions associated with curriculum change. Consistent with Jackson et al. (2018), participants described friction between district emphases on instructional improvement and instructional management. Whereas curriculum departments prioritize pedagogical growth, central office leadership often focuses on compliance and timelines, creating misalignment that can complicate new initiatives and place DMSs in the difficult position of persuading teachers, principals, and district leaders to adopt shifting instructional expectations (Jackson et al., 2018). Further research could investigate DMSs' roles as boundary crossers whose work is to communicate mathematics priorities with other district leaders, school leaders, teachers, and community members. They work in a network of different interests and priorities for resources and information about mathematics teaching and learning.

To enact these responsibilities, DMS participants discussed monitoring district access to and use of high-quality instructional resources. Participants described evaluating the quality of print and digital materials, monitoring how frequently resources were used, and gathering information from teachers and students about the usefulness and impact of those materials. This work extended to analyzing student interest and achievement data to assess curricular effects, further illustrating the breadth of DMS responsibilities during periods of instructional change. Although the survey occurred early in the implementation of the newly revised standards, participants' emphasis on attending to standards and curriculum as "boundary objects" was not unique to this moment—it was a routine dimension of their role. Helping teachers interpret standards, anticipate instructional demands, and manage workload through clear pacing and resource structures remained consistent themes in their survey responses.

When discussing the challenges they faced, participants framed their responsibilities around four interconnected areas: (a) mathematics content (i.e., ensuring what is being taught aligns with standards); (b) pedagogy (i.e., supporting how instruction is delivered); (c) assessment (i.e., guiding how learning is evaluated); and (d) coherence across resources (i.e., ensuring alignment among lesson plans, curriculum maps, and instructional materials). This emphasis underscores DMSs' central role in sustaining coherent, standards-aligned mathematics instruction across their districts.

Given the complexity of curriculum-focused work and the pressures shaping DMSs' priority setting, our findings point to several needs. DMSs require structured opportunities to collaborate with peers within districts, across regions, and through professional organizations (e.g., NCSM, NCTM, AMTE) to share challenges, exchange strategies, and codevelop approaches to district- or state-level initiatives. Decisions about the structure, frequency, and facilitation of such collaboration are essential to ensuring sustained, meaningful support. As DMSs navigate both urgent and long-term curriculum-related pressures, these professional networks are critical for strengthening their capacity to lead coherent, research-informed instructional improvement across their districts.

Designing and Delivering Professional Learning Opportunities for DMSs

Surveyed DMSs identified several areas of professional learning they wished to explore, including current research on mathematics teaching and learning, strategies to engage all students in challenging problem-solving tasks, and designing mathematics lessons with teachers that incorporate such tasks. These results reflect the critical need for DMSs to remain informed about current research and to develop strategies for supporting teachers in designing and implementing high-quality mathematics instruction. Many DMSs occupy positions as the sole mathematics leader at the district level, though some districts include related leadership roles aligned to instructional levels (e.g., elementary and secondary mathematics supervisors). Regardless of district structure, regular opportunities for professional learning, mentorship, and peer support are essential for sustaining DMS effectiveness and reducing professional isolation. The sharing and codesign of tools and resources with leaders from other districts could also enhance curriculum coherence and statewide initiatives (Stephan et al., 2025).

The diversity of DMS participants' experiences highlights the ongoing need for professional learning tailored to individual and district contexts. Participants' shared interest in their own development suggests professional organizations can play a pivotal role in supporting these leaders as implementers and interpreters of changes and innovations in mathematics education. Ensuring equitable access to professional learning—including mentorship, networking, and varied delivery methods—may strengthen the capacity of DMSs to lead coherent, research-informed instructional improvement across districts.

Mentoring and structured support systems are particularly important for DMSs who are new to their roles. The continuing advancement of technology now enables easier sharing, collaboration, and creation of resources, making it possible for DMSs to connect even if they are physically isolated. Given the increase in access to technology in schools in response to the COVID-19 global pandemic, a unique opportunity exists to leverage these tools to better connect DMSs within and across states to address shared challenges. The facilitation of online professional development is crucial, as is the need to support DMSs in engaging in professional learning communities in a virtual environment. Doing so might allow DMSs to explore what others in their profession are doing and how aspects of this work may be shared. Further, a need exists for collaboration between DMSs and professional societies (e.g., NCSM, NCTM). Such collaborations can help meet DMSs' professional learning needs by increasing opportunities for dialogue and sharing successful strategies as well as common challenges. Exploring these avenues may allow DMSs to learn from one another and create a network that fosters continued growth and support.

CONCLUSION

In sum, this exploratory study accentuated the multifaceted responsibilities of DMSs, highlighting their central roles in supporting teachers; translating standards into practice; and sustaining coherence across curriculum, instruction, and assessment. Findings reveal that DMSs navigate tensions between instructional improvement and system management while addressing both short- and long-term district goals. Their work is shaped further by access to high-quality resources and the need for collaboration with peers and professional organizations to reduce isolation and share effective practices. Supporting DMSs through tailored professional learning, mentorship, and structured networks is critical to strengthening their capacity to lead research-informed instructional improvement. These insights point to the importance of continued research and targeted supports to enhance the effectiveness and sustainability of DMS leadership within complex educational systems.

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APPENDIX A

The following survey incorporated items adapted from multiple sources, including Baker et al. (2022) and the Middle-School Mathematics and the Institutional Setting of Teaching (MIST, n.d.) Coach Survey, to gather information about DMS respondents' backgrounds, professional roles, and experiences supporting mathematics instruction.

Part I – Background Information

1. First name
2. Last Name
3. School District
4. Which region is your division located in? (*Region 1, Region 2, Region 3, Region 4, Region 5, Region 6, Region 7, Region 8*)
5. Official Title
6. How many years have you been serving in this role? Put a '1' if this is your first year.
7. How many schools do you provide mathematics support to?
8. What grade levels/bands are you **certified to teach mathematics**? Select all that apply. (Early Childhood, Elementary, Middle, High, Other – please provide)
9. In your role as a **mathematics leader,** what grade levels/bands **do you work with**? Select all that apply. (Early Childhood, Elementary, Middle, High, Other – please provide)
10. Are you credentialed/certified/endorsed by the state of Virginia as a mathematics specialist?
    a. Yes. Please indicate where certification/endorsement was received.
    b. No.
    c. Currently seeking certification as a mathematics specialist. (Please indicate where you are seeking certification/endorsement from.)

Part II – Participant Responsibilities

11. So far this school year (including Summer 2023), to what extent have you assisted mathematics teachers with the following? (Not at all, To a small extent, To a moderate extent, To a great extent)
    a. Clarifying the key mathematical ideas in a particular lesson or unit
    b. Understanding different ways in which students solve a particular problem
    c. Clarifying why certain mathematical ideas are difficult for students to understand
    d. Teaching mathematical ideas that are usually difficult for students to understand
    e. Acquiring materials related to mathematics instruction
    f. Implementing classroom-based formative assessment techniques (e.g., observations, interviews)
    g. Establishing classroom routines and procedures (e.g., collecting homework)
    h. Managing the behavior of specific students
    i. Matching the curriculum to the mathematics standards
    j. Using state test scores to improve instruction
    k. Planning for instruction
    l. Using the district's curriculum or pacing guide
12. So far this school year (including Summer 2023), have **you** provided any district-based professional development (workshops, seminars) to mathematics teachers? (Yes, No)
13. So far this school year (including Summer 2023), how much time in total hours have you spent **as a facilitator** for professional development workshops or seminars in mathematics, mathematics education or mathematics instructional coaching? (0, Less than 6, 6–15, 16–35, More than 35)
14. So far this school year (including Summer 2023), to what extent have you addressed the following topics when providing district-based professional development (workshops, seminars) for mathematics teachers? (Not at all, To a small extent, To a moderate extent, To a great extent)

   a. Meeting state standards or assessment requirements
   b. Managing the classroom and/or student discipline
   c. Analyzing students' mathematics work
   d. Deepening teachers' knowledge of mathematics
   e. Leading discussions in which students have to justify their mathematics solutions
   f. Understanding the central mathematical ideas in the curriculum
   g. Using challenging, problem-solving tasks
   h. Using strategies to engage all students in challenging, problems solving tasks
   i. Effectively using the adopted curriculum
   j. Understanding how student mathematical reasoning develops
   k. Planning and/or providing classroom instruction
   l. Planning and/or providing student intervention(s)
   m. Planning and/or providing teacher intervention(s)
   n. Planning and/or implementing family and community events
15. So far this school year (including Summer 2023), to what extent have you expected your mathematics teachers to do the following activities? (Not at all, To a small extent, To a moderate extent, To a great extent)
   a. Adhere to a prescribed pacing in their instruction
   b. Make sure their students' test scores improve
   c. Address the state/district objectives and standards
   d. Have whole classroom discussion in which students explain how they solved tasks
   e. Have small group discussion in which students explain how they solved tasks
   f. Use the adopted curriculum as a basis for their classroom instruction
   g. Keep students quiet and disciplined during classroom instruction
   h. Use challenging, problem-solving tasks with their students
   i. Use students' current mathematical thinking to inform their instruction
   j. Collaborate with other mathematics teachers
   k. Observe others' mathematics teaching
   l. Use me as a resource when instructional problems arise
   m. Make their lesson plans available for review
   n. Assist other mathematics teachers in improving their instruction
   o. Adjust instruction to meet the needs of low achieving students
16. Do you visit mathematics teachers' classrooms (Yes, No–Skip to Q18 if no)
17. To what extent do you agree or disagree with the following statement?: "My purpose in visiting mathematics teachers' classrooms is to . . ." (Strongly disagree, Somewhat disagree, Neither disagree or agree, Somewhat agree, Strongly agree)
   a. Assist them in improving their teaching
   b. Formally evaluate their teaching
   c. Gain a greater understanding of mathematics instruction in my school
   d. Monitor the extent to which teachers are using the adopted curriculum
   e. Monitor teachers' use of a particular instructional tool
   f. Monitor teachers to see if they are implementing an instructional strategy suggested in professional development
   g. Monitor teachers to see the extent to which formative assessment is a component of their planning and instruction
   h. Be visible in the school
   i. Support teachers with classroom management of student behavior
   j. Model instruction in mathematics
   k. Check on particular students' progress in mathematics
   l. Observe teachers with the purpose of providing feedback
18. To what extent are **you comfortable facilitating** professional development on the following topics: (Not at all, To a small extent, To a moderate extent, To a great extent)
   a. Interpreting state mathematics standards
   b. Aligning state standards to an adopted mathematics textbook
   c. Coordinating pacing of mathematics instructional units
   d. Current research on mathematics teaching and learning
   e. Facilitating teachers' analysis of students' mathematics work
   f. Conducting individual conferences with mathematics teachers focused on their teaching practices
   g. Conducting small group meetings of mathematics teachers to support the ongoing improvement of their instructional practices
   h. Deepening teachers' knowledge of mathematics
   i. Creating district formative assessments in mathematics
   j. Implementing classroom-based formative assessment techniques

   k. Fostering relationships of trust among mathematics teachers
   l. Supporting mathematics teachers in using the adopted curriculum
   m. Modeling instruction for mathematics teachers
   n. Designing challenging, problem-solving mathematics lessons with teachers
   o. Strategies to engage all students in challenging, problem-solving tasks
   p. Understanding how students mathematical reasoning develops
   q. Understanding the central mathematical ideas in the adopted curriculum
   r. Theories of teacher (or adult) learning
19. To what extent do **your supervisors** expect you to do the following things? (Not at all, To a small extent, To a moderate extent, To a great extent)
   a. Lead professional development activities for mathematics teachers
   b. Assist mathematics teachers in resolving student behavioral problems
   c. Observe mathematics teachers and provide feedback to improve teaching
   d. Examine students' mathematical work with teachers
   e. Hold grade-level or department meetings focused on mathematics instruction
   f. Help teachers understand how student mathematical reasoning develops
   g. Demonstrate effective teaching practices in mathematics
   h. Work with him/her/them to align curriculum with state standards
   i. Interpret district or state mathematics standards with teachers
   j. Communicate mathematics teachers' concerns to the principal
   k. Communicate mathematics teachers' concerns to district leaders
20. To what extent do **principals** expect you to do the following things? (Not at all, To a small extent, To a moderate extent, To a great extent)
   a. Lead professional development activities for mathematics teachers
   b. Assist mathematics teachers in resolving student behavioral problems
   c. Observe mathematics teachers and provide feedback to improve teaching
   d. Examine students' mathematical work with teachers
   e. Hold grade-level or department meetings focused on mathematics instruction
   f. Help teachers understand how student mathematical reasoning develops
   g. Demonstrate effective teaching practices in mathematics
   h. Work with him/her/them to align curriculum with state standards
   i. Interpret district or state mathematics standards with teachers
   j. Communicate mathematics teachers' concerns to the principal
   k. Communicate mathematics teachers' concerns to district leaders

Part III – Participant Professional Learning

21. So far this school year (including Summer 2023), how much time in total hours have you spent **as a participant** in professional development workshops or seminars in mathematics, mathematics education or mathematics instructional coaching? (0, Less than 6, 6-15, 16-35, More than 35)
22. To what extent would you like to **receive professional development** on the following topics: (None at all, A little, A moderate amount, A lot, A great deal)
   a. Interpreting state mathematics standards
   b. Aligning state standards to the adopted mathematics textbook
   c. Coordinating pacing of mathematics instructional units
   d. Current research on mathematics teaching and learning
   e. Facilitating teachers' analysis of students' mathematics work
   f. Conducting individual conferences with mathematics teachers focused on their teaching practices
   g. Conducting small group meetings of mathematics teachers to support the ongoing improvement of their instructional practices
   h. Deepening your knowledge of mathematics
   i. Creating district formative assessments in mathematics
   j. Implementing classroom-based formative assessment techniques and providing related feedback opportunities.
   k. Fostering relationships of trust among mathematics teachers
   l. Supporting mathematics teachers in using the adopted curriculum
   m. Modeling instruction for mathematics teachers
   n. Designing challenging, problem-solving mathematics lessons with teachers
   o. Strategies to engage all students in challenging, problem-solving tasks
   p. Understanding how students mathematical reasoning develops
   q. Understanding the central mathematical ideas in the adopted curriculum
   r. Theories of teacher (or adult) learning

23. During this school year (including Summer 2023), think about who you have turned to for advice or information about teaching mathematics. Please list the **role/position** of this person(s).
24. What types of advice or information do you seek from these individuals? Please check all options that apply.
    a. Doing mathematics problems together with discussions of different solution strategies
    b. Discussing different ways students are likely to solve tasks
    c. Discussing why some students didn't learn as expected in a lesson in order to plan for future instruction
    d. Analyzing examples of student work in order to adjust instruction
    e. Analyzing examples of student work to understand the different ways that students solve problems
    f. Analyzing student work to see if students "got it"
    g. Discussing how to make use of student solution strategies in whole class mathematical discussions
    h. Discussing pacing
    i. Discussing what materials to use for a lesson
    j. After a lesson, sharing whether students "got it"
    k. Sharing materials or activities
    l. Updating one another on a student or students' progress in mathematics
    m. Other – Please list:
25. How often do you seek advice? (*Daily or almost daily, Once or twice per week, Once or twice per month, A few times per year*)
26. Overall, how influential is the advice you received? (Not at all, Somewhat, Very)

Part IV – Participant Implementation of District Initiatives

27. In your district, who are the math leaders in the **elementary schools** that support the implementation of district initiatives?
    a. Classroom teachers
    b. Math lead or Department chair
    c. Math coaches
    d. Instructional coaches
    e. Principals
    f. None
    g. Other – Please list:
28. In your district, who are the math leaders in the **middle schools** that support the implementation of district initiatives?
    a. Classroom teachers
    b. Math lead or department chair
    c. Math coaches
    d. Instructional coaches
    e. Principals
    f. None
    g. Other – Please list:
29. In your district, who are the math leaders in the **high schools** that support the implementation of district initiatives?
    a. Classroom teachers
    b. Math lead or department chair
    c. Math coaches
    d. Instructional coaches
    e. Principals
    f. None
    g. Other – Please list:

Part V – Open-Ended Response

30. As a district leader, what are your **current or short-term goals** this year (2023–2024)?
31. As a district leader, what are your **long-term goals** for the next 3–5 years?
32. What or who **influences** your goal setting?
33. What are the **challenges** you face as a district leader?
34. What are the **instructional** needs of your school district?
35. What are the **resources** needed in your school district?
36. Would you be willing to participate in a follow-up interview? (Yes, please provide an email address, No)

ESTABLISHING CONDITIONS FOR ONLINE MATHEMATICS COACHING: HOW COACHES INITIATE PARTNERSHIPS WITH TEACHERS

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ABSTRACT

This descriptive study examined how 10 experienced mathematics coaches discursively created conditions for one-on-one, online coaching cycles during preliminary discussions with teachers. These coaches were preparing to support teachers in implementing ambitious mathematics teaching practices, challenging work that often requires teachers to make substantial changes to their instruction and coaches to provide customized, responsive support. Using a modified analytic framework from the medical field, we analyzed "getting to know you" conversations between 18 coach–teacher pairs, focusing on how coaches balanced gathering data, sharing information, and building rapport. We illustrated the content of these discursive behaviors and identified key commonalities and differences that shed light on how experienced mathematics coaches initiate responsive coaching partnerships.

Keywords: mathematics coaching, online professional development, coaching cycles, discourse analysis

In ambitious mathematics teaching, teachers engage students in nonroutine, cognitively demanding tasks and use students' thinking as the foundation for instruction (Lampert & Graziani, 2009; Smith & Stein, 2018). The potential benefits of ambitious mathematics teaching are substantial; such practices provide authentic opportunities for all students to develop reasoning and problem-solving skills, deepen their understanding of important mathematical ideas, and cultivate identities as capable mathematical thinkers (Boaler & Staples, 2008; Schoenfeld, 2014). However, realizing these benefits often requires teachers to make significant shifts, or even complete transformations, in their instruction (Horn & Garner, 2022; Walsh et al., 2023). Ambitious teaching can push mathematics teachers to reconsider long-held beliefs about teaching and learning and to deepen their mathematical and pedagogical content knowledge (Ball et al., 2008). Moreover, teachers must develop new pedagogical skills for making in-the-moment instructional decisions based on students' thinking, including facilitating rich mathematical discussions and supporting students' productive struggles through purposeful questioning (Franke et al., 2009; Jacobs et al., 2010).

One-on-one coaching has emerged as a promising form of professional development (PD) for supporting teachers in implementing ambitious mathematics instruction (Kraft & Hill, 2020; Walsh et al., 2023; Witherspoon et al., 2021; Yurekli & Stein, 2024). In one-on-one coaching, a coach with full- or part-time release from teaching directly supports a mathematics teacher to improve their instruction (Baker et al., 2022; McGatha & Rigelman, 2017). The strength of one-on-one coaching is its capacity to provide mathematics teachers with responsive and personalized support aligned with their individual goals, needs, and instructional contexts (Kochmanski & Cobb, 2023; Saclarides & Munson, 2021). Although this responsiveness can help teachers navigate the numerous and diverse challenges associated with enacting ambitious teaching practices, it also presents complexities for coaches who must balance intentionality with adaptability to meet teachers' diverse needs. Authors of practitioner-oriented resources in mathematics education have frequently acknowledged this tension and have highlighted conditions that enable productive, responsive coach–teacher interactions (Baker & Knapp, 2023; Smith et al., 2024; West & Cameron, 2013; Wills & Rawding, 2019). Collectively, this body of work emphasized that mathematics coaches striving to help teachers make significant changes to practice should engage in intentional, preliminary actions when initiating their partnerships. Yet, few empirical studies have examined how mathematics coaches establish the foundation for authentic, responsive partnerships during their initial interactions with teachers as they prepare to collaboratively implement ambitious mathematics teaching.

The objective of this descriptive study was to understand how mathematics coaches facilitated preliminary discussions with teachers to establish initial conditions for upcoming one-on-one, online coaching cycles focused on the implementation of ambitious teaching practices. We asked 10 experienced coaches, partnered with 19 middle grades (i.e., Grades 4–10) teachers of mathematics as part of a larger PD project, to facilitate a 20–30 minute "getting to know you" (GTKY) conversation before starting online coaching cycles. Broadly, we aimed to characterize the nuanced ways coaches discursively interacted with teachers as they established the foundation for their new partnership in a relatively short period of time. This process included

analyzing how coaches managed the diverse tasks of sharing information about themselves and upcoming work, gathering information about their teachers, and building rapport. Additionally, we aimed to identify commonalities, along with nuanced differences, in the ways experienced coaches facilitated these initial conversations. Each coach and teacher brought unique personalities, experiences, and contexts to their preliminary interaction, which, perhaps unsurprisingly, resulted in diverse initial conversations. However, identifying commonalities amid this diversity revealed structural themes in how experienced coaches launched their partnerships with teachers. Our study answered the question: In an initial conversation with a teacher, how do experienced mathematics coaches discursively create conditions for future one-on-one coaching interactions? As we discuss in the following section, this study's findings are relevant not only to mathematics coaches working with teachers in online spaces (Carson & Choppin, 2021) but also to coaches working in person with teachers.

THEORETICAL FRAMING

We considered conditions for learning to be the whole set of factors influencing a learner's ability to grow in a particular experience (Gagne, 1985). Among the many learning conditions present in one-on-one coaching, we considered three conditions to be most salient when a coach establishes a new partnership with a teacher: (a) a coach's knowledge of their teacher, (b) the teacher's knowledge of their coach and upcoming learning interactions, and (c) a sense of rapport between the coach and teacher. These three conditions are critical because of the responsive and relational nature of coaching and because they reside in a coach's sphere of control. We argue that the presence of these conditions exists along a continuum, where coaches likely will not establish these conditions fully in an initial GTKY, and these conditions will evolve during each subsequent interaction. In an initial conversation, a coach should establish a foundation for these three conditions to begin fulfilling their duties as a responsive thought partner.

As the first condition, a coach must possess knowledge of their teacher and their teacher's professional practice. Given a teacher's professional practice is a complex compilation of skills, experiences, beliefs, and knowledge (Grossman et al., 2009), coaches must be selective in gathering pertinent information about a teacher's current professional practice in relation to the ambitious mathematics teaching (Baker & Knapp, 2023; Gibbons & Cobb, 2016; West & Cameron, 2013). For example, to act responsively when supporting a teacher to improve their practice, coaches would benefit from knowing as much as possible about a teacher's current beliefs about effective mathematics teaching, equitable instruction, and all students' capacity to think mathematically (National Council of Teachers of Mathematics [NCTM], 2014). Additionally, a coach likely would benefit from understanding a teacher's goals for their own growth (Kochmanski & Cobb, 2023), mathematical and pedagogical content knowledge (Ball et al., 2008), and contextual features of a teacher's professional role (e.g., available curriculum resources, prior experiences with coaching and PD).

The second condition is the teacher's knowledge of their coach and upcoming learning interactions. One-on-one mathematics coaching assumes a collaborative partnership in which two job-alike educators coconstruct new knowledge about pedagogy and content (Smith et al., 2024; West & Cameron, 2013). Therefore, the teacher also must become knowledgeable about their partner in the learning environment (Mosley Wetzel et al., 2017). Additionally, a coach may have an obligation to share information about upcoming interactions with the teacher, so they have adequate knowledge to use coaching support.

The third condition is a sense of rapport between the coach and teacher, which we consider to be a shared perception of a harmonious relationship between two people. Although both the coach and teacher can feel a sense of rapport with their partner, a teacher's sense of rapport with their coach may be of primary concern, given the teacher is making their professional practice public. Furthermore, because any professional change can be emotionally demanding for teachers (Villegas-Torres & Lengeling, 2021), and ambitious teaching practices frequently entail substantial shifts in beliefs and practices, a central responsibility of the mathematics coach is to foster a sense of emotional safety and support throughout the change process (Yurekli & Stein, 2024). Taken together, a coach has numerous obligations during an initial interaction with a teacher and must make intentional decisions, given teachers have little time away from students for coaching conversations.

To connect coaching discourse moves with the establishment of these three conditions, this study integrated the discourse conceptualizations of Gee (2014) and Borko et al. (2008). Gee proposed that analyzing discourse involves examining relationships among three interrelated elements: (a) the language being used, (b) the activity or context from which the talk emerges, and (c) the identities and roles of those engaged in the interaction. Building on this framework, Borko et al., in their analysis of mathematics teachers' discussions of classroom videos, refined Gee's category of "language being used" into two dimensions: (a) content of the statement and (b) type of conversational move used to engage that content. In other words, Borko et al. differentiated between what was said and how it was said.

Synthesizing these conceptualizations, the present study treated each turn of talk in a coaching conversation as comprising three components: (a) the speaker (i.e., coach or teacher), (b) the content (i.e., what is said), and (c) the discourse move (i.e., how it is said). The GTKY conversation provided a shared contextual activity in which these discursive interactions occur. Given the coach's facilitative role in the GTKY, our analysis centered on the content and discourse moves enacted by coaches to understand how they discursively gather knowledge of their teachers, provide teachers with information about themselves and upcoming learning interactions, and cultivate a sense of rapport.

LITERATURE REVIEW

Establishing Conditions for Coaching

Practitioner-facing literature has far outpaced empirical studies involving preliminary interactions of mathematics coaches and teachers. West and Cameron (2013), authors of the content-focused coaching model, suggested a coach's understanding of a teacher's instructional habits, beliefs, and content knowledge is a critical condition for responsive coaching. Both Baker and Knapp (2019) and Wills and Rawding (2019) have emphasized that coaches should coconstruct professional learning goals with teachers ahead of coaching work to ensure responsive interactions stay tethered to a central focus. Similarly, Smith et al. (2024) recommended coaches invite mathematics teachers to identify a small set of instructional challenges to serve as focal points for inquiry and improvement in subsequent coaching interactions. In sum, this thin practitioner literature has begun to delineate the conditions coaches must cultivate during formative phases of one-on-one interactions with teachers and the practices coaches should use when establishing initial conditions for coaching.

A limited number of researchers have empirically examined such conditions underpinning successful one-on-one mathematics coaching. These studies have coalesced around two themes. First, successful coaching requires trusting relationships in which both partners feel comfortable engaging in open and honest dialogue (Bengo, 2016; Cameron, 2015). A coach and teacher must be able to talk honestly about a teacher's practice to collaboratively identify instructional improvement goals and actions that are relevant to the teacher, will impact student learning, and are developmentally appropriate for teachers (Kochmanski & Cobb, 2023). This relational dialogue also includes open discussion about the role of the coach and teacher in the partnership to dispel potential power dynamics in which the coach is perceived as an authority figure (Cameron, 2015). Second, coaching support must be tailored to teachers' organizational contexts (Baker, 2022; Hannan & Russell, 2020), which includes attending to administrative expectations for teachers (Saclarides & Lubienski, 2020), the particular school culture (Baker, 2022), and standardized testing pressures (Saclarides & Kane, 2023).

In sum, practitioner-facing literature and empirical studies have provided a starting point to understand the necessary conditions for impactful coaching. However, what remains unknown is how coaches establish optimal conditions for professional learning during preliminary interactions with teachers. This study took an important first step in addressing this gap.

Online Coaching

Despite the increasing popularity of online coaching, scant literature exists on how coaches should interact with teachers in online spaces to create conditions for productive coaching (Carson & Choppin, 2021; Gregory et al., 2017). The limited empirical literature on online coaching has focused primarily on the affordances of teachers and coaches interacting virtually. As a first example, teleconference software (e.g., Zoom) allows a coach and teacher to collaborate synchronously from different geographical locations, improving the accessibility of coaching, particularly for teachers working in rural areas (Carson et al., 2019). The ability to collaborate synchronously from different physical locations also helps a coach and teacher navigate logistical and scheduling challenges (Callard et al., 2022; Carson et al., 2019), which are inherent challenges of in-person coaching (Gibbons & Cobb, 2017). Improved access and scheduling flexibility have, in turn, made online coaching a less expensive and scalable alternative to in-person coaching (Kraft et al., 2018; Kraft & Hill, 2020). As a second example, online coaching was shown to be an effective alternative to in-person coaching in supporting teacher development (Kraft & Hill, 2020). Teleconferencing software provides a productive modality to replace in-person planning or debriefing conversations (Carson & Choppin, 2021). In place of a teacher and coach collaboratively teaching a lesson, online coaching models have incorporated viewing videos of taught lessons, which can support more thorough reflection and analysis of teaching and student thinking (Callard et al., 2022; Carson & Choppin, 2021).

Professional learning in online spaces can be more impersonal than in-person settings; thus, PD facilitators, including coaches, must carefully consider social and emotional dimensions of online learning experiences (Stenbom et al., 2016). For mathematics coaches working in online spaces, prior researchers have elevated the importance of coaches building relationships (Kidd, 2020) and have noted it is possible for a coach and teacher to cultivate a productive relationship despite not working together in person (Carson & Choppin, 2021). However, little is known about how mathematics coaches establish the initial conditions for online coaching during a preliminary interaction with a teacher, which was the central focus of this study.

METHODS

Participants

Participants were 10 experienced mathematics coaches from across the Pacific Northwest, Midwest, and Northeast regions of the United States. These 10 coaches had diverse, full-time mathematics specialist positions separate from their work in the study's PD program (see Table 1). Coaches were selected to facilitate online coaching cycles with teachers based on the following criteria: (a) multiple years of experience teaching mathematics, (b) multiple years of experience coaching teachers using one-on-one coaching cycles, (c) expertise in the content-focused coaching model that guided all coaching activities (West & Cameron, 2013), (d) expertise in mathematics content in a particular grade range, and (e) expertise in pedagogical concepts central to the PD program (NCTM, 2014; Smith & Stein, 2018).

Table 1
Coach Demographics

Coach participant	Teaching experience (years)	Specialist experience (years)	Mathematics specialist positioning (Baker et al., 2022)	Teachers coached	Grade levels coached
Alice	17	7	Mathematics coach: Organization	2	4, 5
Beth	16	5	Mathematics coach: Organization	2	4, 5
Carter	8	2	Mathematics coach: Organization	2	5, 7–12
Eileen	15	15	Mathematics coach: District level	2	5, 5
Jane	6	2	Mathematics coach: School level	1	6
Laura	10	7	Mathematics coach: Organization	1	8
Maya	12	6	Teacher educator: University	2	6, 6
Ruby	7	7	Mathematics coach: Organization	4	4–5, 5, 6, 7
Susan	7	8	Mathematics coach: Organization	1	3–5
Tom	9	3	Mathematics coach: District level	2	9, 9

Project Context

This study occurred in a state-funded PD program in which 19 middle-grade mathematics teachers, geographically dispersed across the state, participated for 1 year. The program engaged teachers in three professional learning activities, which occurred synchronously in online spaces: (a) course sessions in which teachers learned about ambitious mathematics teaching practices; (b) video clubs in which teachers analyzed video clips of project personnel using new teaching practices in local classrooms; and (c) one-on-one, video-assisted coaching cycles. Project personnel facilitated the course sessions and video clubs, and the 10 participant coaches facilitated the one-on-one, video-assisted coaching cycles. The 19 coach–teacher pairs engaged in three online coaching cycles, which were interspersed across the year of participation, to provide teachers with individualized support to implement ambitious mathematics teaching practices learned in the course sessions and video clubs. The coaching cycles followed a content-focused coaching approach (West & Cameron, 2013), meaning coaches emphasized mathematical content and how students learn that content throughout each phase of the cycle to support teachers' growth in both mathematical and pedagogical content knowledge (Ball et al., 2008). In the planning conversation, the coach and teacher collaboratively design a lesson articulating explicit mathematical learning goals aligned with cognitively demanding tasks. For the lesson implementation, the teacher taught and video recorded the lesson and shared the video with their coach, allowing both the coach and teacher opportunities to view and annotate the lesson ahead of the debriefing conversation. The debriefing discussion centered on analyzing how effectively the lesson supported learning by examining student thinking, identifying factors that influenced the outcomes, and determining next steps for future instruction (see Callard et al., 2022 for a fuller description of these coaching activities).

As part of introductory activities, each coach–teacher pair was invited to have a 20- to 30-minute GTKY conversation via Zoom (given the coach–teacher pairs were geographically dispersed) that occurred approximately 1 month prior to the start of the first online coaching cycle. To support coaches in preparing for these initial meetings, coaches were provided with a set of instructions containing the following statement regarding the purpose of the conversation:

> *In [this project], a primary learning goal for teachers will be understanding and implementing the NCTM Effective Teaching Framework (comprised of eight teaching practices). Often, these practices are referred to as ambitious mathematics teaching practices. In the course, to help make these ambitious practices more specific and tangible for teachers, we will use the text 5 Practices for Orchestrating Productive Mathematics Discussions (2nd ed.; Smith & Stein, 2018). Your primary role will be supporting teachers to (a) understand how to implement the practices they learn in the course and video clubs in their own classrooms, and (b) cultivate planning and reflective habits that will support teachers to use the practices after the project is over. The purpose of the "Getting to Know You" meting is to create a foundation that will support productive interactions towards these goals.*

Coaches were given no instructions about how to facilitate the conversations, leaving ample room for professional discretion.

Data Collected and Analysis

We analyzed the transcripts of 18 GTKY conversations. Although there were 19 coach–teacher dyads in this cohort of participating teachers, two teachers who worked at the same school and were partnered with the same coach decided to attend the same GTKY conversation. Thus, we analyzed 17 transcripts involving coach–teacher dyads and one transcript involving a coach–teacher triad. We included this triad in the analysis because its overall structure and flow of interaction resembled the other coaching conversations, and a single coach facilitated the conversation, which was the focus of our analysis (Schegloff, 2007). These initial conversations were recorded using Zoom and transcribed. There were two steps to the analytic process, detailed in the following sections: (a) creating an analytic framework using the Roter interaction analysis system (RIAS) from the field of medicine, and (b) coding coaches' talk using the framework.

Analytic Framework Creation

To code coach talk turns, we lifted and modified the RIAS, which has been used to analyze doctors' discursive behaviors when interacting with patients (Roter & Larson, 2002). The coding scheme divides a doctor's verbal statements in a conversation into three main categories: (a) gathering information from the patient relevant to providing responsive health care; (b) sharing and educating the patient on appropriate next steps in their care; and (c) rapport building, which entails verbal statements related to relationship-building practices. We argue the three primary behaviors of gathering information, sharing and educating, and rapport building described in the RIAS also broadly characterize a coach's discourse moves (i.e., how they talked; Borko et al., 2008; Gee, 2014) during initial interactions with a teacher. Within the broad discourse moves of gathering information and sharing and educating, we inductively explored the content focus of the information coaches shared and gathered (i.e., what they talked about; Borko et al., 2008; Gee, 2014), given obvious differences in the content of doctor–patient and coach–teacher discussions. However, the relational similarities between doctor–patient and coach–teacher interactions were sufficient to retain the rapport-building codes from the RIAS for our research.

Table 2

Analytic Framework and Coding Scheme for Data Gathering Behaviors

Data gathering behaviors (Coach asks about _____)		
Content focus	Code	Code description
Learning goals and needs	Ask – learning goals	The coach asks the teacher to share their current professional goals and desired growth and/or their expectations for coaching within the PD project.
	Ask – motivation to join	The coach asks the teacher to share their reasons for participating in the current PD project and/or coaching, including prior relationships that influenced their decision to participate.
Logistics	Ask – conversation logistics	The coach asks the teacher to share details about logistics as well as the plan and/or purpose specific to the GTKY conversation.
	Ask – general logistics	The coach asks the teacher about logistical items related to coaching (e.g., technology, the best times to meet).
Prior experience with PD and coaching	Ask – coaching experience	The coach asks the teacher to share their prior experience working with an instructional coach.
	Ask – experience with PD	The coach asks the teacher to share their prior experience engaging in PD as a learner as well as how the current PD project aligns with other past or current PD in which the teacher has participated.
Professional context	Ask – current role and context	The coach asks the teacher to share their current teaching assignment, conditions, successes, challenges, etc.
	Ask – teaching experience	The coach asks the teacher to share their background as a teacher as well as their pathway into teaching.
Professional practice and beliefs	Ask – educational philosophy, vision, or beliefs	The coach asks the teacher to share their beliefs, values, and/or philosophies about teaching, learning, and/or students.
	Ask – professional practice	The coach asks the teacher to share about their current teaching practice.

To make these modifications to the RIAS, we engaged in multiple rounds of open coding of subsets of the data across several coach–teacher pairs using constant comparative methods (Corbin & Strauss, 2008). We parsed coaches' talk turns at the sentence level and coded each sentence of coach talk independently. Teacher talk was not analyzed but instead used for context. The intent was to use the three primary behavioral categories identified in the RIAS (i.e., data gathering, sharing and educating, building rapport) and update the categories and accompanying codes to match the context of an initial coach–teacher conversation as opposed to a doctor talking with a patient. Through the open-coding process, we inductively categorized the questions coaches asked teachers to gather data, the information coaches shared with teachers, and the ways coaches built rapport. Five researchers engaged in the open-coding process, which took several rounds of independent data coding and discussion. This process led to the creation and refinement of an analytic

Table 3
Analytic Framework and Coding Scheme for Sharing and Educating Behaviors

Sharing and education behaviors (Coach shares _____)		
Content focus	Code	Code description
Foregrounding teacher learning	Share – coherence to other PD	The coach shares how the PD project aligns with other past and/or current PD in which the teacher may have participated.
	Share – project learning and expectations	The coach shares the nature, focus, and content of the project's learning experience.
Learning goals and professional interests	Share – professional goals	The coach shares thehir current professional goals and desired growth.
	Share – motivation to join	The coach shares their reasons for participating in the PD project and/or coaching, including prior relationships that influenced their decision to join.
Logistics	Share – conversation logistics	The coach shares details about logistics specific to the GTKY conversation as well as their thinking related to the plan or purpose for the conversation.
	Share – general logistics	The coach shares logistical items related to coaching (e.g., technology, the best times to meet).
Professional context	Share – coaching experience	The coach shares their prior experience working as a coach and/or facilitator of PD as well as their process for becoming a coach. The coach may also share their prior experiences engaging in PD as a learner.
	Share – current role/professional context	The coach shares their current coaching/professional assignment, conditions, classes, successes, and/or challenges.
	Share – teaching experience	The coach shares their teaching background as well as their path into teaching.
Professional practice and beliefs	Share – educational philosophy, vision, or beliefs	The coach shares their beliefs, values, and/or philosophies about coaching, teaching, learning, and/or students.
	Share – professional practice	The coach shares their current coaching and/or teaching practices.

framework containing three parts: data gathering, sharing and educating, and rapport building.

Data Gathering. Through the open coding process, we created 10 codes, which were organized into five categories to accurately characterize the nature of the data coaches gathered about their teachers through questioning (see Table 2). These categories were professional context, logistics, prior experience with PD and coaching, professional practice and beliefs, and learning goals and needs. Codes about professional context involved the coach inviting the teacher to share basic information about their current role, school demographic information, or teaching experience. The logistics category comprised codes in which coaches asked teachers to share basic logistical information about either the GTKY conversation (e.g., how much time was available for this discussion) or general logistical information pertaining to future interactions (e.g., what time of day typically works best for meeting). Codes in prior experience with PD and coaching involved the coach asking the teacher about their prior experiences working with a coach or engaging in professional learning. The professional practice and beliefs category featured codes in which coaches' data gathering moved beyond inviting descriptions of context, logistics, and prior experience, and probed teachers' beliefs or philosophies about teaching, their instructional vision for teaching mathematics (Munter, 2014), or current pedagogical practices. The final category, learning goals and needs, involved codes in which coaches invited teachers to talk about what they wanted to learn from participating in the project or what motivated them to participate in the project.

Sharing and Educating. We created five categories in the sharing and educating coaching behavior to organize the various codes describing the nature of the data coaches shared with their teachers (see Table 3). These categories were professional context, logistics, learning goals and professional interests, professional practice and beliefs, and foregrounding teacher learning. Professional context codes involved the coach sharing details about their current

coaching assignment and previous experiences serving as a teacher and/or coach. Parallel to data-gathering codes, the logistics category encompassed codes in which the coach shared logistical items about future coaching and logistics specific to the GTKY conversation. Learning goals and professional interests involved codes in which the coach shared their own professional goals and/or desired growth as well as their reasons for joining the PD project. Professional practice and beliefs contained codes in which the coach shared their beliefs about coaching, teaching, learning, or students, or their current coaching or teaching practices. Last, the foregrounding teacher learning category included codes in which the coach shared what they anticipated teachers would learn from the PD project and how the PD project may align with other professional learning opportunities in which the teacher participated.

Rapport Building. Our open-coding process revealed strong similarities between rapport-building discursive practices in both medical and coaching contexts. Thus, we retained the rapport-building codes and categories of the RIAS. These three categories were positive rapport building, social rapport building, and emotional rapport building (see Table 4). The category of positive rapport building contained three codes, which encompassed instances in which the coach engaged in humorous interactions with the teacher, gave the teacher compliments, and/or agreed with the teacher. The category of social rapport building contained two codes, both of which involved the sharing or gathering of personal information not inherently relevant to the coach's professional relationship with the teacher. The emotional rapport building category contained six codes, which discursively fostered empathy, concern, and partnership. Furthermore, these codes captured moves in which coaches validated, encouraged, and revoiced teacher-initiated utterances. We note our addition of the code revoice to the RIAS. We found revoice to be a common move coaches used in the initial conversations and placed this code in emotional rapport building based on claims from prior coaching literature that a primary function of paraphrasing is to build rapport (Costa & Garmston, 2016).

Coding Coaches' Talk

Once the framework was finalized, we recoded all 2,849 sentences of coach talk across the 18 GTKY conversations in teams of three. Each team member independently coded each sentence of coach talk in a single transcript using the framework. Each sentence was assigned a single code with the broad dimensions of data gathering, sharing and educating, or rapport building. After the three researchers independently assigned codes, two researchers met and reconciled any discrepancies. Table 5 provides an example of the final codes assigned for three coach sentences through this coding process. For reliability, 83% of coded sentences featured agreement between at least 2 of the 3 coders. Once the pairwise teams reconciled their coding, we compiled codes into a single spreadsheet and identified structural similarities and nuanced differences in the 10 coaches' discursive actions.

Table 4

Analytic Framework and Coding Scheme for Rapport Building Behaviors

Rapport-building behaviors (Coach communicates _____)		
Content focus	Code	Code description
Emotional rapport building	Concern	The coach discursively looks after the well-being of the teacher.
	Empathy	The coach communicates that they understand the perspective or idea shared by the teacher.
	Encouragement	The coach provides encouragement to the teacher.
	Partnership	The coach communicates togetherness with the teacher in upcoming coaching work.
	Revoice/paraphrase	The coach revoices and/or paraphrases utterances made by the teacher to further establish a connection.
	Validation/legitimation	The coach communicates that the idea shared by the teacher is important or worthy.
Positive rapport building	Agreement	The coach agrees with something shared by the teacher.
	Compliments/approval	The coach compliments the teacher or something shared by the teacher, or they approve of something shared by the teacher.
	Humor	The coach makes a humorous utterance.
Social rapport building	Ask – personal life	The coach asks the teacher to share about their family, home life, outside interests, and/or anything not related to professional activities.
	Share – personal life	The coach shares about their family, home life, outside interests, and/or anything not related to professional activities.

Table 5
Example of Our Coding Process

Speaker	Transcript	Dimension	Categories	Code
Teacher	I would love to see, to be able to implement more conversation and discussion with the concepts group.			
Teacher	But I don't know how that would fit with the new curriculum.			
Teacher	So I think it'd be kind of difficult to be learning that and trying to implement it when . . .			
Coach	Right, that makes sense to have a lot of new things all at once, for kids already, that you're just really trying to focus on and feed into as much as possible.	Rapport building	Emotional rapport building	Validation/ legitimation
Coach	And you said, you've been teaching for 3 years.	Rapport building	Emotional rapport building	Revoice/ paraphrase
Coach	So why did you become a teacher?	Data gathering	Teaching context	Ask – teaching experience

FINDINGS

Throughout the GTKY conversations, the coaches engaged in three kinds of talk: data gathering, sharing and educating, and rapport building. We present findings around these three kinds of talk in two ways. First, we provide excerpts to illustrate coaches' differing content foci when enacting these three behaviors. Second, we use percentages to highlight commonalities and differences in how the experienced coaches facilitated these conversations.

Overall, the most prevalent category of coach talk was rapport building because this topic surfaced in an average of 44% of the coach-spoken sentences. Sharing and educating was the second most prevalent category (38%) followed by data gathering (18%). Although this overall trend was evident across coaches, there were instances in which individual coaches deviated from this overall pattern. For example, Tom frequently enacted rapport building (52%) and data gathering (36%) but seldom deployed sharing and educating (12%) talk. Furthermore, Eileen evidenced a near-even split between the three types of talk, spending approximately one third of her time engaged in each category of talk. Table 6 contains percentages and counts for each coach for each category of talk and an average across coaches.

Table 6
Overall Percentage Distribution of Sentences Coded as Data Gathering, Sharing and Educating, and Rapport Building

Code	Alice	Beth	Carter	Eileen	Jane	Laura	Maya	Ruby	Susan	Tom	Avg.
Data gathering (%)	7	14	13	32	14	14	22	21	12	36	18
Sharing and educating (%)	56	43	42	35	33	26	41	43	47	12	38
Rapport building (%)	37	43	45	34	54	60	38	36	41	52	44

Data Gathering: Illustrations

When gathering data about teachers, coaches' questions coalesced around five topics (see Table 7), and we illustrate each content foci of coaches' data gathering in the following sections.

Table 7
Percentage Distribution of Content Related to Coaches Data Gathering, Sharing and Educating, and Rapport Building

Code/content	Alice	Beth	Carter	Eileen	Jane	Laura	Maya	Ruby	Susan	Tom
Data gathering										
Professional context (%)	18	52	53	54	40	42	27	36	41	34
Logistics (%)	0	0	3	0	0	0	4.2	0	0	5
Prior experience with PD and coaching (%)	41	2	19	0	27	5	0	25	14	0
Professional practice and beliefs (%)	29	31	13	29	33	32	54	13	23	29
Learning goals & needs (%)	12	14	13	17	0	21	15	26	23	32
Sharing and educating										
Professional context (%)	59	31	29	53	28	44	66	36	17	0
Logistics (%)	19	14	19	40	11	12	11	17	21	57
Learning goals and interests (%)	7	7	5	5	6	6	9	11	11	0
Professional practice and beliefs (%)	10	37	26	3	8	9	5	23	14	29
Foreground teacher learning (%)	6	12	22	0	47	29	9	13	37	14
Rapport building										
Positive rapport building (%)	14	20	36	30	17	13	18	16	25	19
Social rapport building (%)	14	33	11	5	15	24	24	5	35	0
Emotional rapport building (%)	72	47	53	65	68	64	58	79	39	81

Professional Context

To illustrate how coaches gathered data from teachers around the two codes in this category, we highlight Carter's questions. In his two conversations with teachers, Carter asked basic contextual questions (coded as ask – teaching experience) such as, "What grades have you taught?" Carter also asked more open-ended questions about his teachers' prior teaching experience, including, "What is your favorite thing about your teaching experience?" Furthermore, Carter gathered contextual data about his teachers' current roles and work environments, including teachers' access to math tasks (coded as ask – current role and context). These questions included, "How much access do you have to rich tasks, and do you know where to find them?" Professional context questions seemed to enable coaches to better understand their teachers' contexts, supporting the coaches in customizing their coaching efforts to specific teachers' needs.

Logistics

Coaches spent little energy gathering data about logistics, with only three coaches asking any questions related to conversational logistics (e.g., "Are you still at school now?") and general logistics (e.g., "What works best for when you and I meet?"). Coaches spent more time sharing and educating when discussing logistics, and we return to this point in later sections.

Prior Experience With PD and Coaching

We characterized questions focused on prior experience with PD and coaching using two codes (i.e., ask – coaching experience and ask – experience with PD) and illustrate their use through Alice. In her two conversations, Alice asked her teachers questions about their prior experiences working one on one with a coach (e.g., "Have you done one-on-one coaching before with a coach?"). Alice also gathered data about her teachers' background knowledge of the pedagogical content in the upcoming professional learning session (e.g., "Since this project will use the book, *Five Practices for Orchestrating Mathematics Discussions*, I was wondering what background you have with that book?"). Through these questions, Alice gathered data both about teachers' experiences engaging in the activity of one-on-one coaching and their prior familiarity with the content of upcoming professional learning sessions.

Professional Practice and Beliefs

To illustrate how coaches gathered data about teachers' typical instructional habits (coded as ask – teaching practice) and teaching beliefs (coded as ask – educational philosophy, vision, or beliefs), we highlight questions from Beth and Maya. Beth asked her teacher, "What kind of tasks do you usually do in your classroom? Do you do tasks like [the prior course session], or is that something new to you?" To understand teachers' instructional beliefs, philosophies, and visions, coaches used a variety of open prompts. For example, Beth invited teacher discussion with prompts, such as, "Tell me about your own math story." Maya used different prompts, such as, "Who was one of your favorite teachers and what made them memorable?" Through these questions, Beth and Maya gathered data about teachers' current states of teaching as well as their beliefs and visions about their idealized classrooms.

Learning Goals and Needs

The final category in data gathering (i.e., learning goals and needs) involved coaches asking about teachers' professional growth goals (coded as ask – learning goals) and their rationale for joining the project (coded as ask – motivation to join). In contrast to the diverse ways coaches explored teachers' instructional practice and beliefs, questions

involving these codes tended to be more direct and explicit. To illustrate this pattern involving data gathering about teachers' professional growth goals, Tom asked both his teachers, "What goals do you have for yourself this year?" To understand teachers' hopes for their growth, coaches also asked direct questions about why teachers enrolled in the project. For example, Alice asked both her teachers, "What brought you into this project?" Coaches honored teachers as professionals who had the autonomy to select their own PD by explicitly tapping into teachers' perspectives about their own learning goals.

Data Gathering: Noteworthy Consistencies and Variability

We identified two consistencies across the 10 coaches and their 18 conversations, along with two noteworthy differences. For the similarities, all 18 conversations featured data-gathering moves focused on both teachers' professional contexts and professional practices and beliefs. This finding suggested all 10 coaches valued gaining knowledge about the contextual features of teachers' current roles, along with their typical instructional habits and beliefs. Conversely, all coaches infrequently asked questions related to logistics; we identified only four logistical questions across all 18 conversations. Regarding variability, two categories in data gathering (i.e., prior experience with PD and coaching, learning goals and needs) had a large range across the coaches. For prior experience with PD and coaching, Beth, Tom, Eileen, and Maya spent little-to-no time gathering data on this topic, whereas at least 25% of questions from Alice, Ruby, and Jane invited teachers to discuss prior professional learning experiences. Similarly, the percentage of questions coded as learning goals and needs ranged from 0% (Jane) to 32% (Tom), highlighting different coaches' actions in terms of wanting to learn about teachers' learning interests.

Additionally, we found substantial diversity in the questions coaches asked to learn more about teachers' professional practice and beliefs. As previously shared, Beth prompted teachers to talk about their "math story" and a recent lesson that was successful. Maya asked her teachers about their favorite mathematics teacher and how this teacher influenced their current teaching. Alice and Eileen invited their teachers to talk about their perfect or ideal mathematics classrooms. Jane asked her teacher to describe their "mindset" for teaching mathematics and was more direct, asking her teachers to talk about specific instructional habits (e.g., how they typically launch and close lessons). In sum, the diversity in coaches' questions suggested gathering information about all facets of teachers' professional practice and beliefs is a large task requiring multiple approaches.

Sharing and Educating: Illustrations

When sharing with and educating teachers, coaches' verbal statements centered around five topics (see Table 7), and we illustrate the different content foci in the following sections.

Professional Context

When making statements about their own professional contexts, the coaches shared information about their current coaching positions and contexts (coded as share – current role and context) and their previous experiences teaching and coaching (coded as share – teaching experience and share – coaching experience, respectively). To illustrate, we highlight Maya's statements. Across her two conversations with teachers, Maya not only shared information about her prior teaching experience (e.g., "I started teaching in 2007. I started in a smaller school district, in the math department for a middle school for seventh and eighth grade."), but she also shared information about her previous coaching experience ("My last 4 years in K–12 public education, I was an instructional coach. I was outside of the classroom. I had students, but my students were teachers."). Additionally, Maya provided her teachers with information about her current professional context ("I am now working for [a midwestern university] with preservice teachers."). In sum, professional context statements established the coaches' current professional identities, authority, and contexts while drawing upon their prior coaching and teaching experiences.

Logistics

Logistical sharing statements provided teachers with information about the upcoming coaching sessions (coded as share – general logistics) and logistics regarding the GTKY conversations (coded as share – conversation logistics). To illustrate, Eileen started her conversation by sharing her discursive plan with her teachers, saying, "I have some questions to know you a little bit better, about your teaching experience and your classroom. Just to get a sense for who you are and what your experiences have been." These sentences were coded as share – conversation logistics because Eileen spoke directly about her plan for the GTKY conversation. Throughout the coaching conversation, Eileen touched on logistics as it related to the technology they would use in online coaching cycles (e.g., "The Swivl is just a robot. It's a pod that holds an iPad, and it's going to follow you."), which was coded as share – general logistics because Eileen shared details about technological logistics pertaining to future experiences. Overall, the sharing of such logistical statements provided teachers with important information about the timing and execution of the GTKY conversation and future coaching interactions and technology upon which they would be dependent in upcoming interactions.

Learning Goals and Interests

The learning goals and interests sharing category encompassed statements in which the coaches either discussed: (a) their current professional goals and desired growth (coded as share – professional goals) or (b) their reasons for participating in the current PD project (coded as share – motivation to join). To illustrate, across her four conversations, Ruby made clear her motivation for joining the project, saying, "My heart is working with teachers and working at rural schools." Furthermore, Ruby articulated her own professional learning goals, noting, "I'm going to come to these course sessions when I'm able. I can always learn from a different speaker. I feel like I will have my learner hat on." Although this category was not a prevalent talk category (see Table 7), 9 of 10 coaches briefly discussed their learning goals and professional interests. In doing so, the coaches positioned themselves as learners alongside their teachers, which appeared to be important for most of the project coaches.

Professional Practice and Beliefs

When discussing their professional practice and beliefs, the coaches shared details regarding their current coaching

and/or teaching practices with teachers (coded as share – professional practice) and information about their overarching philosophy, vision, or beliefs regarding education (coded as share – educational philosophy, vision, or beliefs). To illustrate a statement coded as share – educational philosophy, vision, or beliefs, Beth shared her belief that students can persevere when problem solving if teachers can work to develop students' agency and self-efficacy. She said, "If you can help [students] develop that agency and that self-efficacy that 'I can do this!'—that is where you can get kids to persevere in problem solving." The coaches' statements functioned to establish themselves as professionals by sharing their teaching and coaching practices and beliefs with teachers.

Foregrounding Teacher Learning

Last, when coaches foregrounded teacher learning, they made sharing statements with teachers about what teachers might learn through their engagement in the project (coded as share – project learning and expectations) and how what teachers learned in the project might connect to other PD they had experienced (coded as share – coherence to other PD). To illustrate, Jane shared, "I think [your instructional goal] resonates heavily because *5 Practices*, it's all about the quality of instruction and the quality of student thinking and the quality of teacher facilitation of using student thinking to drive lessons." We coded this sentence as share – project learning and expectations because Jane discussed how her teacher's learning goals would be addressed through the upcoming PD project. To depict a statement coded as share – coherence to other PD, Laura shared, "So it sounds like this project is in alignment with this current initiative." In this statement, Laura established connections between the PD teachers would experience in the current project and other ongoing PD initiatives. In sum, foregrounding teacher learning statements centered teachers' identities as learners in the context of the coaching partnership, which was essential given that the purpose of coaching is to support teacher learning in service of enhanced outcomes for students.

Sharing and Educating: Noteworthy Consistencies and Variability

Of the three behaviors, sharing and educating had the largest variability in all conversations, ranging from 12% (Tom) to 56% (Alice). In sharing and educating, noteworthy variability existed in the category of foregrounding teacher learning. Eileen did not align any of her talk moves with this category, whereas both Jane and Susan spent considerable time talking to their teachers about upcoming learning experiences and how these related to prior PD experiences. Additionally, substantial variability existed in the extent to which coaches shared their own professional practice and beliefs. For Beth and Carter, over one quarter of their sharing and educating moves focused on their own educational beliefs and/or coaching practices, whereas Eileen, Jane, Laura, and Maya rarely shared such content.

For similarities, we noted two patterns. First, coaches seldom talked about their own learning goals and interests, with such moves ranging from 0%–11% of coaches' sharing and educating moves. Conversely, all coaches, other than Tom, discussed their own professional context. Although the frequency of professional context talk ranged from 17%–66% of all sharing and educating moves, the trend suggested a coach sharing about their own professional context may be an important part of introductory meetings in which the coach and teacher are not located in the same school or district.

Rapport Building: Illustration

Rapport-building statements were prevalent in all conversations, ranging from 34% (Eileen) to 60% (Laura) of all coded coach sentences (see Table 6). Although all coaches used rapport-building moves, we found notable distinctions in how coaches attempted to build rapport with teachers across the three categories from the RIAS (Roter & Larson, 2002; see Table 7).

Positive Rapport Building

Positive rapport building encompassed instances in which the coach used humor, compliments, and/or agreement when communicating with their teacher. Such positive rapport building moves typically were dispersed throughout the conversations and often were part of coaches' responses after teachers shared information. To illustrate, we highlight the actions of Carter, who frequently used combinations of humor and compliments throughout his conversations when responding to his teachers. In one conversation, Carter invited his teacher to discuss her project learning goals. After the teacher shared their desire to grow students' confidence in learning mathematics, Carter stated, "I really like that. That's probably the best version of that I have ever heard. 'Hey, you want to come do my job sometime?'" In this statement, the first two sentences were coded as compliment because Carter praised the teacher's statements. The third sentence was coded as humor because Carter playfully suggested the teacher's thoughtful statements qualified her to be a coach.

Social Rapport Building

Social rapport building involved the coach asking or sharing information related to one's personal life. For Ruby, Eileen, and Carter, social rapport-building moves were limited to brief questions or singular statements about a teacher's family in response to a shared personal statement (e.g., "How old are your kids?"). In contrast, Alice and Maya dedicated portions of the conversation for personal discussion that was catalyzed using social rapport-building moves. For example, both coaches provided teachers with open-ended prompts (e.g., "Tell me about yourself.") at the start of conversations, allowing teachers the opportunity to talk about their personal lives. After teachers shared, the coaches reciprocated, sharing similar personal information through short monologues. In Alice and Maya's conversations, after these short monologues from both the coach and the teacher, no additional social rapport-building moves were used. For Beth, Susan, and Laura, social rapport-building moves were salient across the entire conversation. For example, Laura routinely interjected personal anecdotes about family, typical daily routines, idiosyncratic behaviors, and pets throughout the conversation. In sum, coaches' varied use of social rapport-building moves made personal discussion notable features of some conversations, but not all.

Emotional Rapport Building

Emotional rapport-building moves encompassed instances in which the coach expressed empathy, validation, concern,

partnership, or encouragement or paraphrased teachers' statements. Like positive rapport-building moves, different emotional rapport-building moves were used in tandem and typically were part of coaches' responses after teachers shared information. For example, Eileen tended to use validation and paraphrase moves after teachers shared about what "students would know and be able to do" in their "perfect classroom." As one example, after the teachers shared, Eileen said:

> *So this connection to the real world seems very important, plus student agency and discourse and then rich tasks. And I love, Ella, how you said that there's still a need for the management piece, because the engagement has to be high to be able to do that.*

Eileen's first sentence was coded as paraphrase because she summarized the teachers' statements. Eileen then used a validation move, communicating that the teachers' ideas were important.

A second trend in coaches' use of emotional rapport building was communicating concern for and a desire to be respectful of teachers' limited time (coded as concern) during their conversations. For example, in five instances across a single conversation, Jane shared statements such as, "I really want to respect your time." In this statement, the coach attended to the teacher's well-being by respecting the limited amount of time the teacher had to meet.

A third trend in the coaches' use of emotional rapport-building moves was coaches delivering short monologues involving explicit statements about partnership. For example, Alice shared the following in one of her conversations:

> *I think we have a lot of the same beliefs towards teaching and learning. So, this is going to be a super fun partnership. And from my perspective, as a coach, I always enter into it as a true partnership. Like, I want to take just as much shared ownership of the lesson. And even though I won't ever be in your classroom, what happens is on both of us. It's a learning opportunity for both of us.*

All sentences in Alice's statements were coded as partnership, as she spoke about her excitement to begin a new partnership and her role in the partnership in forthcoming interactions.

Rapport Building: Noteworthy Consistencies and Variability

Perhaps the most noteworthy finding in this study is the prevalence of emotional rapport-building moves found across all 10 coaches. Such moves were prominent for all coaches, ranging from 47% (Beth) to 81% (Tom) of all moves coded as rapport building. In this broad prevalence, coaches used emotional rapport-building moves in unique ways. For example, Beth tended to use statements of empathy and partnership, whereas Eileen used numerous paraphrase and validation moves. Despite these subtle differences, coaches also exhibited similarities with all coaches using emotional rapport-building moves in tandem with data-gathering moves (e.g., sharing statements of validation, empathy, or encouragement after teachers shared ideas). Furthermore, 9 of 10 coaches delivered monologues about partnership and repeatedly shared statements of concern regarding teachers' limited time.

In contrast, there was substantial variability in the coaches' use of social rapport-building moves, which ranged from 0% (Tom) to over 30% (Beth and Susan) of all rapport-building moves. This trend was noteworthy because we anticipated these meetings would feature social discussion, which was a chance for a coach and teacher to get to know each other on a personal level prior to academic-focused interactions. Social rapport-building moves also played different roles in the conversations for coaches who used them. For example, for Alice and Maya, personal discussion was confined to alternating monologues, whereas Beth, Susan, and Laura infused personal discussion across the entire conversation. In sum, the findings suggested emotional rapport-building moves were critical for all coaches, though each coach varied slightly in the moves they favored. In contrast, social rapport-building moves were not a common feature of all conversations and appeared to be more individualistic.

DISCUSSION

Prior research has shown one-on-one coaching can be an effective way to support mathematics teachers to enact ambitious teaching practices (Kraft & Hill, 2020; Stein et al., 2022; Witherspoon et al., 2021). Yet, research on mathematics coaching has tended to emphasize outcomes of coaching with less focus on unpacking the moment-to-moment interactions through which such support unfolds. Responding to recent calls for descriptive analyses that illuminate how mathematics coaches navigate the complex task of providing support that is both responsive and intentional (Yurekli & Stein, 2024), this study offered new insights into the interactional practices mathematics coaches use when initiating coaching partnerships. Our analysis of experienced coaches' GTKY meetings revealed how coaches begin establishing relationships and pedagogical focus in preparation for online coaching cycles aimed at helping teachers adopt ambitious instructional practices. Our findings extended existing coaching knowledge in at least three ways.

First, the analysis revealed both consistencies and differences in how mathematics coaches facilitated their initial conversations with teachers. Because each coach and teacher brought distinct goals, contexts, experiences, and personalities to these interactions, some variation was expected. However, consistencies across the 10 experienced coaches pointed to practices that may represent salient features of early coach–teacher interactions preceding the intensive, intellectually demanding work of supporting the use of ambitious teaching practices. For example, all 18 conversations included data-gathering moves focused on teachers' professional contexts as well as their professional practices and beliefs, indicating coaches prioritized understanding both the contextual features of teachers' roles and their typical instructional approaches and beliefs. Given that effective mathematics coaching must be responsive to teachers' unique contexts and needs, these early conversations may serve as critical opportunities for coaches to learn about teachers' current practice to tailor support accordingly (Kochmanski & Cobb, 2023). Moreover,

the frequent use of emotional rapport-building moves by all 10 coaches may reflect the relational groundwork required for coaching aimed at ambitious mathematics teaching, work that often asks teachers to take professional risks, make their teaching public, and engage in deep reflection about practice. The consistencies identified in this study may illuminate how experienced mathematics coaches commonly prioritize certain discourse moves before engaging in more instructionally focused collaboration.

To illustrate these distinctions further, consider the coaching actions of Tom and Beth. Across two conversations, Tom never used social rapport-building moves and used relatively few sharing and educating moves. Beth, in contrast, averaged 22 social rapport-building moves across her conversations and frequently shared her own professional context and professional practice and beliefs. Despite these differences, both Tom and Beth—along with all other coaches—consistently used numerous emotional rapport-building moves and favored questions targeting teachers' professional practices and beliefs and learning goals and needs. These patterns suggested that although some moves (e.g., social rapport building) may reflect an individual coach's personal style, others (e.g., emotional rapport building, data gathering) appear to be characteristic features of initial coaching conversations that set the stage for the deeper, instructionally focused work of supporting ambitious mathematics teaching.

Second, virtual mathematics coaching has become increasingly prevalent, and prior studies have shown it (a) is an effective way to support teacher development (Kraft & Hill, 2020) and (b) can make coaching accessible to all teachers regardless of their geographical location (Carson & Choppin, 2021; Gregory et al., 2017). Despite the promise of virtual mathematics coaching, researchers have noted a potential challenge of online learning interactions: the lack of in-person connections can lead to impersonal experiences (Kidd, 2020). As coaching assumes a strong, authentic coach–teacher partnership, understanding how mathematics coaches establish the foundation for teacher partnerships in online spaces is critical. This study's findings are applicable to mathematics coaches working one on one with teachers in either in-person or online modalities. Prior studies (Russell et al., 2020; Stein et al., 2022; Witherspoon et al., 2021) and practitioner texts (Baker & Knapp, 2023; Smith et al., 2024; West & Cameron, 2013) have suggested all mathematics coaches, regardless of coaching modality, are tasked with acting responsively to an individual teacher's unique needs, goals, and contexts. Furthermore, all coaches face the challenge of limited time to interact with teachers (Kane & Rosenquist, 2019; Saclarides & Lubienski, 2020). Thus, our study filled a critical gap in mathematics coaching literature, presenting detailed descriptions of the discursive decisions experienced coaches made when using a short amount of time to establish conditions for future coaching.

Finally, the adaptation and use of the RIAS as an analytic lens for coaching conversations provided methodological contributions for studies examining mathematics coaches' and small group facilitators' discursive behaviors. Prior studies on how mathematics coaches distribute intellectual authority during coaching cycle conversations have focused on coaches' use of directive and reflective coaching moves (Gillespie et al., 2025; Saclarides et al., 2024; Witherspoon et al., 2021). Directive moves (e.g., suggesting, explaining) involve a coach positioning themselves as the knowledgeable authority in a conversational moment, and reflective moves (e.g., questioning) position the teacher as the primary authority. The primary behaviors of data gathering and sharing and educating in the RIAS parallel reflective and directive coaching moves, respectively. However, data gathering and sharing and educating do not necessarily connect to the larger construct of intellectual authority and instead describe basic and observable facilitative behaviors, making this framework applicable in diverse professional learning contexts. For example, directive coaching moves lack applicability in a GTKY conversation because a coach telling a teacher about their professional background does not position the coach as a knowledgeable authority in the same way as a coach explaining mathematical content to a teacher during a planning discussion (Gillespie et al., 2025; Saclarides et al., 2024). However, the broader behavior of sharing and educating would be applicable to preliminary discussions as well as planning and reflective discussions in coaching cycles because it characterizes a fundamental facilitative behavior. Furthermore, the rapport-building codes provide practical ways to capture coaching moves that may foster relationships and emotional connection in discussions focused on content and pedagogy, a useful contribution given that coaching assumes an authentic and trusting partnership between two educators (Baker & Knapp, 2023; Smith et al., 2024; West & Cameron, 2013). The broad applicability of our coding scheme also could be used to understand the discursive behaviors of facilitators working with small groups of mathematics teachers. Prior studies have shown that developing a shared sense of community is a key condition of collaborative small-group learning experiences (Lefstein et al., 2020; van Es, 2012), and the framework in this study could support the field in understanding how facilitators establish community. Thus, our study presents a framework that can be adapted and used to analyze the ways coaches, and other facilitators, engage teachers in both intellectual discussion about mathematics teaching and learning while building rapport.

IMPLICATIONS

This study has implications for researchers who wish to build upon its findings and for practitioners (e.g., coaches and other school leaders in school districts).

Implications for Research

Our sample was relatively small and consisted of 10 experienced mathematics coaches who engaged teachers in online coaching cycles in the context of a grant-funded PD project. Partnering with 10 experienced mathematics coaches was an intentional sampling decision to draw upon our coaches' extensive expertise and showcase the kinds of discourse possible in GTKY conversations. However, results should be interpreted in this particular context because they do not necessarily generalize to all coach–teacher interactions. Future researchers can build upon this study's findings and partner with a larger, more diverse group of mathematics coaches, including novice coaches who are in

their first few years serving as coaches and coaches who coach primarily in person as opposed to in virtual settings.

As previously discussed, the primary purpose of this exploration was to better understand the types of discourse possible during initial coach–teacher conversations, with the goal of establishing conditions for upcoming coaching cycles. As such, this study was descriptive in nature because we sought to unpack the black box of what those conversations look like. However, a limitation of the study was our focus on coaches' actions without attention to teachers' responses or the subsequent coaching cycle conversations. Thus, our study was unable to make any empirical claims regarding the extent to which these coaching actions and conversations were productive. Although the common practices displayed by experienced coaches may signal features associated with productive coaching (Gibbons & Cobb, 2016; Witherspoon et al., 2021), future research is needed to examine how coaches' facilitative actions in initial conversations relate to teachers' responses and outcomes from subsequent coaching cycles before drawing such conclusions.

Last, our team unearthed methodological complexities during the analytic process. As previously shared, we assigned codes at the sentence level and aggregated counts for categories of talk, so we could make claims about the prevalence of talk categories for individual coaches and for the coaches as a whole group. We noticed that when gathering data about a teacher's beliefs regarding teaching and learning, a coach may have posed just one question that generated a thoughtful and thorough response from the teacher. We also noticed that when sharing information about their own beliefs regarding teaching and learning, the same coach may have needed to share many sentences to articulate their beliefs fully. The inherent differences between asking questions and providing information may have created an imbalance in the counts, making some talk categories more prevalent than others. We invite researchers to continue to grapple with us about how to best code and count such data to provide descriptive analyses.

Implications for Practice

Mathematics coaches may understand the importance of establishing conditions with teachers ahead of future coaching work centered on ambitious mathematics teaching, but they may not know how to establish those connections. The framework in our study, along with our illustrative examples, can serve as professional learning tools to introduce mathematics coaches to the three major categories of talk (i.e., data gathering, sharing and educating, rapport building) and the associated subcodes, definitions, and examples. From this starting place, coaches can then be supported to use the framework as a planning and reflection tool for initial interactions with teachers. We encourage those tasked with providing mathematics coaches with ongoing, job-embedded professional learning opportunities to use our framework and findings to support coaches in considering diverse ways to discursively establish conditions for future coaching work with teachers.

For facilitators of professional learning experiences for mathematics coaches (e.g., district-level administrators, principals), we emphasize that the framework is not prescriptive, and the categories do not represent a checklist of topics to be covered in preliminary discussions. Instead, the framework offers a broad menu of discursive behaviors and content that may enable coaches to responsively engage individual teachers based on their unique needs and varied contexts. For example, if a mathematics teacher is unfamiliar with ambitious mathematics teaching practices or has never had professional or personal interactions with their coach before, it may be important for the coach to discursively spend more time deploying rapport-building moves to establish a trusting coach–teacher relationship. Conversely, if a coach is working with an experienced teacher with whom they already have a strong personal relationship, the coach may spend more time deploying data gathering and sharing and educating moves.

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