Aspects of High-Quality Mathematics Coaching: What Coaches Need to Know and Be Able to Do to Support Individual Teachers' Learning

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For Sydney, who is forever loving and patient

and

For my kids, those I taught and those I never had the chance to meet

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CHAPTER I

INTRODUCTION

Currently, states across the country are implementing standards that specify rigorous goals for students' mathematical learning (e.g., Peterson Barrows, & Gift, 2016; Stage, Asturias, Cheuk, Daro, Hampton, 2013). These standards have implications for the work of mathematics teaching, such as teachers' development of *ambitious instructional practices* that can support students' attainment of rigorous learning goals (Kazemi, Franke, & Lampert, 2009; Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010; Lampert & Graziani, 2009). For many teachers, these ambitious instructional practices differ significantly from their current forms of instruction. Teachers' development of these practices therefore requires that they reorganize aspects of their current instructional practices (e.g., Wood, Cobb, & Yackel, 1991). A growing body of research indicates that this professional learning requires sustained, job-embedded support (Cohen & Hill, 2001; Darling-Hammond & Richardson, 2009).

Many schools and districts are currently implementing one-on-one mathematics coaching as a strategy for supporting mathematics teachers in improving their instructional practices. Conceptually, the rationale for one-on-one coaching is based on the premise that co-participation with a more accomplished other in activities close to practice can support the development of more sophisticated practices (e.g., Lave & Wenger, 1991). Empirically, evidence of the effectiveness of coaching is mixed. While some studies have found that one-on-one coaching can support teachers to improve the quality of their instruction (e.g., Kraft, Blazar, & Hogan, 2018; Russell et al., 2016; Teemant, Wink, & Tyra, 2011), other studies have found little if any positive

effect on teachers' instructional practices and students' learning (e.g., Garet et al., 2008; Carlisle & Berebitsky, 2011).

Research on coaching has made significant progress in recent years, and scholars have begun to clarify the types of one-on-one coaching activities that can support individual teachers' learning when enacted well, such as co-teaching, modeling instruction, and conducting one-on-one coaching cycles with teachers (e.g., Gibbons & Cobb, 2017). These activities clarify what coaches can do to support teachers' learning. Studies have also begun to clarify what coaches need to know and be able to do to enact one-on-one coaching activities effectively with teachers (e.g., Gibbons & Cobb, 2016; Haneda, Teemant, & Sherman, 2017; Hindman & Wasik, 2012; Russell et al., 2016; Russell et al., 2017). For example, Russell and colleagues (2016) found that it is important for coaches to engage teachers in discussions in which they link content learning goals, students' thinking, and instruction when planning lessons during coaching cycles. Taken together, these findings begin to clarify what constitutes high-quality coaching.

While research has begun to clarify aspects of high-quality coaching, variation in the quality of one-on-one coaching that teachers receive remains a primary explanation for coaching's mixed effects (e.g., Atteberry & Bryk, 2011; Matsumura, Garnier, & Spybrook, 2012; Blazar & Kraft, 2015). There are a number of potential reasons for this variation in quality. For example, the size of a coach's caseload (Atteberry & Bryk, 2011), state and district policies (Coburn & Russell, 2008; Deussen, Coskie, Robinson, Autio, 2007), and coaches' relationships with their principals can influence the nature and quality of their work with teachers (e.g., Gibbons, Garrison, & Cobb, 2011; Grant & Davenport, 2009; Matsumura, Sartoris, Bickel, & Garnier, 2009). High-quality coaching that can support individual teachers' learning is also complex, demanding work that requires substantial expertise beyond that involved in being an

accomplished teacher (e.g., Bengo, 2016; Gallucci, Van Lare, Yoon, & Boatright, 2010; Gibbons & Cobb, 2016). Many coaches will therefore require support if they are to, in turn, support teachers' learning. This means it is essential for both researchers and practitioners to understand what coaches need to know and be able to do to enact high-quality one-on-one coaching effectively. This can inform efforts aimed at supporting coaches' learning, and thus efforts aimed at improving the quality of coaching that teachers receive.

Though the coaching literature has made many recent advancements, there are still gaps in our understanding of the coaching-specific expertise required to enact one-on-one mathematics coaching effectively, particularly with regard to the range of purposes particular coaching activities can serve in supporting teachers' learning, how coaches can identify and negotiate instructional improvement goals with teachers, and how coaches can use tools to augment and improve their work with teachers. With this in mind, this dissertation reports on three separate studies that address each of these gaps, in turn. In doing so, I aim to further clarify what mathematics coaches need to know and be able to do to support individual mathematics teachers' learning.

In the first study of my dissertation, I delineate a set coaching practices for which there is evidence that they can support in developing ambitious instructional practices. I do so in order to further clarify what constitutes high-quality coaching. I identified these practices by reviewing the literature on content-focused coaching. Each of the practices I identified consist of 1) a specific type of coaching activity (e.g., modeling); 2) the purpose for enacting that activity (e.g., modeling to demonstrate a particular instructional practice, modeling to highlight students' current capabilities in a content area); and 3) the knowledge and perspectives required to enact that activity in a way that accomplishes the intended purpose. In the course of this analysis, I

identified nine one-on-one coaching practices that serve five distinct coaching functions. In identifying these practices and their associated functions, I address gaps in our current understanding of when and why particular types of coaching activities are useful in supporting individual teachers' learning. The nine identified practices (and their associated functions) also further clarify goals for coaches' learning. These goals can then inform designs aimed at supporting coaches' learning.

In the second study of my dissertation, I report on an investigation of two consequential aspects of one-on-one coaching practice that have yet to be addressed in detail in the coaching literature. Specifically, I investigated how mathematics coaches can 1) identify productive goals for individual teachers' learning, and, on that basis, 2) negotiate improvement goals with teachers, such that coaches and teachers agree upon a productive goal that teachers see as worthwhile. Evidence indicates that these two aspects of coaching are essential if coaches are to support individual teachers learning (e.g., Gibbons & Cobb, 2016; Robertson et al., in press); however, current research on coaching provides little guidance regarding how can coaches accomplish these tasks productively. In examining the processes by which coaches can identify and negotiate goals productively, I address this gap in the current coaching literature. Specifying these two processes also further clarifies what coaches need to know and be able to do to enact one-on-one coaching effectively, and thus points to provisional coach learning goals. These goals can then inform efforts to support coaches' learning.

Finally, the third study of my dissertation examined mathematics coaches' uses of *practical measures* of instruction in one-on-one coaching (for more on practical measures, see Bryk, Gomez, Grunow, & LeMahieu, 2015). Practical measures of instruction are designed to provide educators (e.g., teachers, coaches, district leaders) with rapid feedback that enables them

to determine whether or not changes in instruction are improvements. It is important that practical measures are quick and relatively easy to administer so that they can be used on an ongoing basis in educational improvement initiatives, such as one-on-one coaching.

The primary goal of this third study was to understand whether and if so how coaches' use of a practical measure of instruction in one-on-one coaching can enable them to be more effective in supporting teachers' learning than would otherwise be the case. To investigate this issue, I focused on coaches' use of a practical measure in one-on-one coaching cycles. In the course of my analysis, I identified two additional ways in which coaches can use practical measures to improve their coaching, beyond just determining whether changes in teachers' instruction constitute improvements. These findings contribute to our understanding of practical measures and their use in educational improvement initiatives, as well our understanding of what coaches need to know and be able to do to use practical measures effectively in their coaching.

In sum, the overarching aim of this dissertation is to clarify what coaches need to know and be able to do to enact one-on-one coaching effectively, and thus support individual teachers' learning. The three studies reported on in this dissertation constitute a significant step towards this goal and contribute to research on mathematics coaching by: a) delineating coaching practices for which there is evidence that they can support teachers' learning; b) clarifying how coaches can identify and negotiate instructional improvement goals productively; and c) specifying whether and, if so, how coaches' use of a practical measure of instruction can enable them to be more effective in their coaching than would otherwise be the case. Further, all three studies have pragmatic implications, as the findings of each study clarify goals for supporting coaches' learning. These goals can then inform the design of supports for coaches' learning, such as coach professional development.

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CHAPTER II

EXAMINING RESEARCH ON COACHING: IDENTIFYING HIGH-QUALITY ONE-ON-ONE COACHING PRACTICES

Introduction

Currently, states across the country are implementing new standards that outline more rigorous goals for students' learning (e.g., Peterson Barrows, & Gift, 2016; Stage, Asturias, Cheuk, Daro, Hampton, 2013). In mathematics, these goals center on students' development of conceptual understanding, procedural fluency, and mathematical practices (e.g., constructing mathematical arguments, critiquing the reasoning of others). Researchers have reached an empirically grounded consensus on the kinds of *ambitious instructional practices* that can support students in attaining these rigorous mathematical learning goals (e.g., Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010; Lampert & Graziani, 2009). These practices include, for example, selecting cognitively demanding mathematics tasks (Stein, Grover, & Henningsen, 1996; Stein & Lane, 1996), introducing tasks so that all students can begin working productively without lowering the cognitive demand (Jackson, Shahan, Gibbons, & Cobb, 2012), and facilitating mathematics discussions in which students are pressed and supported to explain their reasoning and make connections between different solution strategies (Kazemi & Stipek, 2001; Stein, Engle, Smith, & Hughes, 2008). For many mathematics teachers, these practices differ significantly from their current instructional practices. Teachers' development of ambitious instructional practices therefore requires that they reorganize aspects of their teaching (e.g.,

Wood, Cobb, & Yackel, 1991). Research indicates that this professional learning requires sustained, job-embedded support (Cohen & Hill, 2001; Darling-Hammond & Richardson, 2009).

There is increasing evidence that one-on-one coaching can support teachers in improving their instructional practices when coaching programs are designed and implemented well (e.g., Kraft, Blazar, & Hogan, 2018). There is also evidence that one-on-one coaching is challenging, relational work (e.g., Coburn & Russell, 2008; Gallucci, Van Lare, Yoon, & Boatright, 2010). Much as high-quality teaching involves "appropriately using and integrating specific moves and activities in particular cases and contexts, based on knowledge and understanding of one's pupils and on the application of professional judgment" (Ball & Forzani, 2009, p. 497), high-quality coaching involves using and integrating specific coaching activities in particular cases and contexts, based on knowledge and understanding of teachers and students, and on coaches' application of professional judgment. In other words, high-quality coaching involves understanding the types of coaching activities that can support teachers' learning, when and why particular coaching activities are useful in supporting teachers' learning, as well as the knowledge and perspectives involved in being able to enact those coaching activities effectively with teachers.

Research on high-quality coaching has made significant progress in recent years and has identified the types of one-on-one coaching activities that have the potential to support teachers' learning. These potentially productive activities include, for example, modeling instruction, co-teaching, and engaging teachers in coaching cycles (Gibbons & Cobb, 2017; Russell et al., 2016; Russell et al., 2017). At the same time, there is a small but increasing literature that examines the practices of accomplished coaches as they either prepared to enact or enacted potentially productive coaching activities (e.g., Gibbons & Cobb, 2016; Haneda, Teemant, & Sherman,

2017; Olson & Barrett, 2004; Russell, 2015). Some of these studies clarify when and why coaches can engage teachers in particular types of coaching activities. For example, Gibbons and Cobb (2016) closely examined the planning practices of an accomplished mathematics coach, finding that the coach modeled instruction to support teachers in developing a clearer vision of particular instructional practices and co-taught lessons with individual teachers to support them in enacting particular instructional practices more effectively with their students. However, scholars have yet to analyze across these studies to reach a consensus on the *full range* of purposes for particular kinds of activities. Doing so can further clarify when and why particular types of coaching activities are useful in supporting individual teachers' learning.

Finally, recent studies in the coaching literature have also made progress in specifying the knowledge and perspectives involved in enacting one-on-one coaching effectively. By knowledge and perspectives, I mean the ways in which coaches frame particular situations or interactions (perspectives) and the interpretations, decisions, and judgments made within – or based on – particular framings (knowledge). For example, Jackson and colleagues (2015) found that enacting coaching effectively involves the perspective that teachers' learning is a process of development rather than of acquiring a range of separate skills. At the same time, other studies indicate that enacting coaching effectively involves pedagogical content knowledge (Gibbons & Cobb, 2016; Matsumura, Garnier, & Resnick, 2010; Campbell & Malkus, 2014) and knowledge of teachers' learning trajectories (Gibbons & Cobb, 2016). However, researchers have yet to clarify the knowledge and perspectives involved in enacting *particular types* of one-on-one coaching activities effectively *for particular purposes*. This is important because the knowledge and perspectives involved in enacting particular types of activities effectively may differ depending on coaches' purposes for those activities.

Thus, there is a need to further clarify both when and why particular types of coaching activities are useful in supporting teachers' learning, as well as what coaches need to know in order to enact those activities effectively for those purposes. In this study, I addressed these two issues by identifying a set of one-on-one coaching practices for which there is evidence that they can support teachers' learning. Each of the practices consists of 1) a specific type of coaching activity, 2) the purpose for enacting that activity, and 3) the knowledge and perspectives required to enact that activity in a way that accomplishes the identified purpose. By integrating these aspects of coaching, I clarify when and why particular types of one-on-one coaching activities are useful in supporting individual teachers' learning, as well as what coaches need to know in order to enact those activities for those purposes. The findings of this analysis can then inform the design of professional development aimed at supporting coaches in enacting potentially productive coaching activities effectively with teachers.

To identify high-quality coaching practices, I conducted a review of existing research on high-quality one-on-one coaching. In this review, I analyzed instances of effective coaching to determine what coaches did to support teachers' learning, why they did it, and also the knowledge and perspectives involved in doing that work well. While my primary focus was on mathematics coaching, the literature on mathematics coaching is thin. Therefore, I included investigations of coaching in other content areas, such as English Language Arts (ELA) and science, in my review. In what follows, I first describe the criterion I used to identify instances of high-quality one-on-one coaching in the literature. Next, I propose and justify a definition of coaching practices by drawing on the teacher education literature. I then describe my methods for analyzing the relevant literature, followed by my findings and a discussion of those findings in relation to what is currently known about high-quality coaching.

High-Quality Coaching:

Supporting Teachers' Development of Ambitious Instructional Practices

The primary goal of coaching is to support teachers in developing instructional practices that can better support students in attaining rigorous learning goals, such as those outlined in the Common Core State Standards (CCSS). Evidence that teachers are making progress in developing these kinds of instructional practices can therefore indicate that the associated coaching is of high quality. As mentioned previously, scholars have reached an empirically grounded consensus on the types of *ambitious instructional practices* that can support students in attaining rigorous learning goals (Kazemi, Franke, & Lampert, 2009; Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010; Lampert & Graziani, 2009). Broadly speaking, ambitious instructional practices involve engaging students in challenging, non-routine instructional tasks or activities; eliciting students' reasoning as they are engaging in those tasks or activities; and then building on that thinking in order to support students in developing a deep understanding of key disciplinary ideas (e.g., Grossman et al., 2009). In this study, I take teachers' development of these kinds of ambitious instructional practices as an indication of high-quality coaching, and thus as a criterion for identifying instances of high-quality coaching in the current literature.

High-Quality Coaching Practices

For the purposes of this study, I define high-quality coaching practices as comprising the specific *types of activities* in which coaches engage teachers to support their learning (i.e., what coaches do), coaches' *purposes* for enacting those activities with teachers (i.e., why coaches do what they do), and the *knowledge* and *perspectives* inherent in enacting the activities in ways that

can support teachers' development of ambitious instructional practices. Following scholarship in practice-based teacher education (e.g., Jansenn, Grossman, & Westbroek, 2015), I include the purposes for enacting specific coaching activities in my definition of coaching practices in order to account for the professional judgment involved in supporting others' learning. Doing so necessarily clarifies the functions of particular coaching activities, thereby outlining the underlying rationales that are central to the coaching profession.

I also distinguish between knowledge and perspectives in my definition of coaching practices. I use the term "perspectives" to refer to the ways in which coaches frame particular situations or interactions. For example, coaches might frame teachers' learning as a process of development *or* as a process of remediating gaps in teachers' knowledge (e.g., Jackson et al., 2015). These different frames have implications for the ways in which coaches engage with teachers, and are thus integral to coaching practices. On the other hand, I use the term "knowledge" to account for the interpretations, decisions, and judgments made within (or based on) particular framings. Thus, different perspectives have implications for coaches' knowledge. For example, approaching teachers' learning from a developmental perspective might involve knowledge of teachers' current practices and how teachers can better support students' learning by reorganizing those practices. In contrast, approaching teachers' learning from a remediation perspective might involve knowledge of weaknesses in individual teachers' current practices how those deficits can be addressed. Because coaches' perspectives and knowledge are integral to the ways in which coaches attempt to support teachers' learning, it is essential to include both in the definition of coaching practices.

By attending to the perspectives, knowledge, and purposes in coaching practices, I address recent criticism in the teacher education community that argues *teaching* practices—or,

in this case, coaching practices—reduce complex, interactional work (e.g., coaching, teaching) into decontextualized skills (Philip et al., 2018). Specifically, my focus on the knowledge, perspectives, and purposes inherent to coaching practices acknowledges that high-quality coaching involves professional judgment, as well as responsiveness to teachers' current practices and the different contexts in which they work. Thus, my definition of coaching practices attends to the challenge and complexity involved in supporting individual teachers' learning, thereby indicating that coaching practices involve more than just decontextualized skills.

Identifying High-Quality One-on-One Coaching Practices

Paralleling research on teacher education (e.g., Ball & Forzani, 2011; Boerst, Sleep, Ball, & Bass, 2011; Grossman et al., 2009), I approached the identification of coaching practices as a process of *decomposing* the work of high-quality coaching "into [its] constituent parts for the purposes of teaching and learning" (Grossman et al., 2009, p. 2069); in this case, coaching and the learning of teachers. As I describe later in my methods, this involved coding studies reporting on instances of high-quality one-on-one coaching for the three key aspects of practice described above: the types of activities in which coaches engaged teachers, their purposes for enacting those activities, and the knowledge and perspectives inherent in the enactment of the activities.

Foregrounding the purposes of key coaching practices enables me to differentiate between instances in which the same type of coaching activity serves different purposes in supporting teachers' learning. For example, a coach might decide to model instruction in order to either a) orient a teacher to students' current capabilities and ways of thinking or b) support a teacher in developing an image of high-quality instruction in a specific content area. In this

illustration, the type of coaching activity (modeling) is the same, but the purpose for enacting the activity with a teacher differs depending on the context and teachers' current practices.

Methods

The goal of this analysis was to identify a set of one-on-one coaching practices for which there is evidence that they are associated with improvements in teachers' instruction. The following question guided this analysis:

1. *In instances of high-quality coaching, what types of coaching activities did coaches enact?*
2. *What were coaches' purposes in enacting those types of activities with teachers?*
3. *What kinds of knowledge and perspectives were integral to the effective enactment of these activities with teachers?*

I addressed these questions in two phases. In the first phase, I identified studies in the coaching literature in which there is evidence that one-on-one coaching actually supported teachers' development of ambitious instructional practices. In the second phase I analyzed across these studies to address the second and third questions. This involved coding the studies for the types of activities coaches enacted with teachers, coaches' purposes in enacting those activities, and the knowledge and perspectives required to enact those activities effectively with teachers.

Phase 1: Identifying Instances of High-Quality One-on-One Coaching

In the first phase of my analysis, I identified research reports with evidence that the described one-on-one coaching actually supported teachers' development of ambitious instructional practices. As a reminder to readers, I did not limit this analysis to studies that

focused on mathematics coaching because the literature on mathematics coaching is thin. I began this process by conducting a broad search of the ERIC (www.eric.gov) and Google Scholar (scholar.google.com) databases to identify an initial set of coaching studies. My search terms included references to coaching (e.g., coach, coaching, one-on-one coaching), references to specific types of one-on-one coaching activities described in the literature (e.g., modeling, co-teaching, or coaching cycle), and references to teachers' learning (e.g., instructional improvement, knowledge and skills, teachers' learning).

I then narrowed the set of identified studies to only those with a focus on a more accomplished other working with individual teachers to support them in developing content-specific instruction practices. I therefore excluded studies of *peer coaching* because they may not involve interactions with a more accomplished other. I also excluded studies of *reform coaching* (or leadership coaching) because these studies do not focus on coaching that aims to support teachers in improving their instruction. Additionally, I removed studies of school-based testing coordinators or interventionists because these studies focus primarily on working with students or data. Further, because my focus is on coaching as a job-embedded support for *currently practicing* teachers, I excluded papers in which a teacher educator coached pre-service teachers during rehearsals (e.g., Kazemi, Ghousseini, Cunard, & Turrou, 2016; Lampert et al., 2013) or during mediated field experiences (e.g., Zeichner, 2010). Finally, I retained only those studies in which the coaching focused on a specific content area. This resulted in an initial set of 61 research reports.

I then analyzed the resulting set of research reports to identify those in which there was evidence that the one-on-one coaching actually supported teachers' development of ambitious instructional practices, thereby retaining only those reports that satisfied my criterion for high-

quality one-on-one coaching. To make this determination, I documented evidence of the participating teachers' development in a series of memos. I then compared this evidence against what is known about ambitious instructional practices in the relevant content areas, retaining only those studies in which the participating teachers made progress in developing ambitious instructional practices. Because of my focus on content-focused coaching, I excluded studies in which the coaching only supported teachers in making general improvements, such as improving classroom management. This resulted in a set of eleven research reports (denoted with an asterisk in the reference list for this paper). Of these eleven reports, ten focused explicitly on one-on-one coaching. One report (Gibbons, Kazemi, & Lewis, 2017) focused on a coach supporting the learning of a group of teachers in mathematics; however, I retained this paper because the authors explicitly note that the focal coach also conducted one-on-one coaching as a complement to her work with this group of teachers.

Phase 2: Decomposing Instances of High-Quality One-on-One Coaching

In the second phase of my analysis, I analyzed the retained research reports in order to specify a set of high-quality coaching practices. This involved decomposing the identified instances of high-quality coaching to specify the types of coaching activities, the purposes for enacting those activities, and the associated knowledge and perspectives, thereby answering each of my research questions. I began this process by first coding each research report for what coaches did to support teachers' development of high-quality instructional practices. In doing so, I specified the types of coaching activities that coaches enacted with teachers. When relevant, I used codes developed in prior research on high-quality coaching to describe these activities. For example, I used the code "modeling instruction" to describe instances in which the coach taught

students as the teacher observed. When there were no relevant codes for particular forms of activity, I used grounded methods (Corbin & Strauss, 2015) to develop inductive codes to describe the types of activities in which coaches engaged teachers.

Next, I coded the relevant research reports for why coaches did what they did, thereby specifying their purposes for engaging teachers in specific coaching activities. As mentioned previously, there are gaps in the field's understanding of the purposes that particular types of activities can serve in supporting teachers' learning. Therefore, I used grounded methods (Corbin & Strauss, 2015) to develop inductive codes for the kinds of purposes that specific types of activities can serve in supporting teachers' learning. Unfortunately, authors of research reports do not always make the purposes of the described coaching activities clear. In these instances, I made inferences about the goals of particular coaching activities by drawing on the findings of other studies. This involved identifying potential purposes for particular coaching activities based on my analysis of other studies, and then matching those purposes based on my developing understanding of high-quality coaching. In taking this analytical approach, I treat my findings about the purposes of specific coaching activities as conjectures that might be revised when analyzing or conducting additional studies of high-quality coaching.

As an illustration of this process, Haneda, Teemant, and Sherman (2017) describe how an accomplished coach conducted ongoing reflective conversations with a partner teacher about key instructional strategies in order to problematize the teacher's current understanding of effective instruction. The findings reported in this paper indicate that, over the course of these conversations, the coach and teacher reached a shared understanding of key instructional practices. This shared understanding then informed the identification of instructional improvement goals for the teacher. Though the authors do not explicitly state that the coach

engaged the teacher in these ongoing conversations in order to negotiate improvement goals, I inferred that this is a potential purpose of this type of activity based on the coaching model described in Teemant, Wink, and Tyra (2011). In this paper, the authors note that a primary aim of initial coaching conversations is to "create shared goals" for teachers' improvement of their instructional practices (p. 688). While these authors do not describe how coaches and teachers can reach conclusions about these goals effectively, this indicates that negotiating shared instructional improvement goals is a purpose of particular kinds of coaching conversations.

Having coded the retained research reports, I next summarized the results of this coding process in a series of memos that documented both the resulting set of coaching activities and their associated purposes. This enabled me to identify cases in which the same coaching activity can serve different purposes in supporting teachers' development. I then organized the identified coaching activities according to their associated purposes, thereby outlining an initial set of practices. By foregrounding purposes, I treated the same activities serving different purposes as separate practices.

To this point, the identified coaching practices integrate the types of activities and their purposes in supporting teachers' learning. However, it is also essential to address what coaches need to know in order to effectively implement particular types of activities effectively with teachers. To address this is issue, I examined the decisions that the authors of research reports made in selecting coaches for their studies, as well as the design decisions they made when supporting coaches in working effectively with teachers. I took this approach because the majority of the studies in the coaching literature do not explicate the knowledge and perspectives inherent in the enactment of specific coaching activities. However, almost all of the studies are grounded in principled decisions about selecting and/or supporting coaches' development. I

inferred the authors' assumptions about the kinds of knowledge and perspectives required to enact particular coaching activities from these selection and design decisions.

When relevant, I coded these selection and design decisions using constructs from research on teaching, teacher education, and coaching, such as content knowledge for teaching (e.g., Ball, Thames & Phelps, 2008; Hill, Ball, & Schilling, 2008), vision of high-quality instruction (e.g., Munter, 2014), and views of students' current capabilities in a content area (Jackson, Gibbons, & Sharpe, 2017). As an illustration of this process, Matsumura, Garnier, and Spybrook (2012) noted that, prior to working with teachers, the participating coaches engaged in professional development that focused, in part, on how specific instructional practices might support students' learning. This design decision indicates that the researchers saw coaches' knowledge of key instructional practices and coaches' visions of high quality instruction as central to the effective enactment of the subsequent coaching activities. Therefore, I applied the codes "pedagogical content knowledge" and "vision of high-quality instruction" to indicate the kinds of knowledge and perspectives implicit in the enactment of the coaching activities described in this study. It is important to note that some of my conclusions about the knowledge and perspectives required to enact particular coaching activities are highly inferential. As a consequence, the claims I make about the knowledge and perspectives integral to the enactment of high-quality coaching practices should be viewed as conjectures based on my analysis of the coaching literature.

Having conducted this phase of the analysis, I then linked the resulting codes for the identified knowledge and perspectives with my codes for activities and purposes in a second set of analytic memos. In doing so, I documented the four defining aspects of high-quality coaching practices. Lastly, I organized the identified practices according to their purposes in supporting

teachers' learning. In doing so, I differentiated between practices that feature the same type of one-on-one coaching activity but differ in their purposes.

Findings

My analysis of the relevant coaching literature resulted in the identification of nine one-on-one coaching practices. Because some of these practices serve similar functions in one-on-one coaching, I have organized my findings according to the five overarching functions that emerged from my analysis. In the sub-sections below, I describe the overarching function and draw on the papers I reviewed in order to illustrate the particular practices relevant to those functions. I also describe the perspectives and ways of knowing implicated in the enactment of each coaching practice.

Function 1: Identify developmentally appropriate next steps for individual teachers' improvement of their instructional practices

Based on my analysis of the literature, "identifying developmentally appropriate next steps for individual teacher's improvement of their instructional practices" is the first key function of one-on-one coaching. This function involves positioning a teacher's current practice in relation to a vision of high-quality instruction, and thus long-term goals for the teacher's learning, thereby constructing a developmental trajectory for teachers' learning (Gibbons & Cobb, 2016). As I note below, coaches can both observe classroom instruction and elicit teachers' reasoning about instruction in order to document teachers' current instruction, which they can then analyze in relation to a vision of high-quality instruction to identify goals for individual teachers' improvement. In many ways, this coaching function is essential to high-

quality coaching because these goals inform the decisions coaches make about how best to support individual teachers' learning (e.g., Gibbons & Cobb, 2016).

Observing classroom instruction. The first coaching practice for the aforementioned function is "observing classroom instruction." Three of the papers reviewed in this study include examples of coaches observing classroom instruction in order to make sense of how teachers were *currently* teaching, and thus identify developmentally appropriate next steps for individual teachers' learning (Haneda, Teemant, & Sherman, 2017; Olson & Barrett, 2004; Teemant, Wink, & Tyra, 2011). In all three papers, coaches observed classroom instruction prior to determining next steps for teachers' learning, indicating this practice is likely an essential starting point for working with teachers productively. Conducting an observation to determine developmentally appropriate next steps likely ensures that the subsequent coaching work focuses on aspects of instruction that are feasible for particular teachers and that are likely to make a different in students' learning. Coaches can then monitor and adjust their work with teachers based on subsequent observations.

Olson and Barrett (2004) provide a clear illustration of this practice. They describe how a focal coach began her work with a teacher by observing the teacher's instruction twice, taking notes on what happened during the observation, and then creating records of the teachers' instruction for each classroom observation. These records indicated that the teacher "typically modeled a solution strategy whenever students were frustrated" (p. 68). Based on this analysis, the coach developed a provisional learning trajectory for the participating teacher, noting that maintaining the cognitive demand of tasks was an appropriate next step for the teacher. Teemant, Wink, and Tyra (2011) also illustrate this practice and describe how the ELA coaches in their study conducted baseline observations of teachers' instruction in order to establish a starting

point for working with teachers. This allowed each coach "to establish where the teacher was developmentally" on an observation rubric (p. 688). The coaches then used this information to determine what they might work on next with teachers. The coaches subsequently conducted additional observations to adjust the focus of their coaching work in response to the teacher's developing practice.

I also identified the knowledge and perspectives implicated in the enactment of this coaching practice. First, this practice implicates a developmental perspective on teachers' learning (Gibbons, Kazemi, & Lewis, 2017), which involves framing teachers' learning as a process of making successive improvements in their instructional practice *towards* more sophisticated forms of practice, rather than a process of acquiring isolated practices and discrete skills (Gibbons, Kazemi, & Lewis, 2017). Absent this developmental perspective, a coach might work with a teacher on isolated skills or quick fixes, rather than supporting a teacher in building *from* her current instructional practices toward the development of more sophisticated instructional practices.

Second, I conjecture that this coaching practice also implicates a sophisticated vision of high-quality instruction (e.g., Munter, 2014). This is because coaches are likely to compare their observations of teachers' instructional practice against their vision of high-quality instruction in order to identify next steps in the teachers' learning (as seen in Olson & Barrett, 2004; Teemant, Wink, & Tyra, 2011). The sophistication of a coach's vision of high-quality instruction matters for this practice because it specifies the long-term goal for the teacher's learning. For example, a mathematics coach with a more traditional vision of high-quality mathematics instruction could observe the same lesson as a coach with a more ambitious instructional vision and reach different conclusions about what would constitute immediate and long-term improvements.

Eliciting teachers' reasoning about instruction. The second practice for this function involves "eliciting teachers' reasoning about instruction" in order to make decisions about how teachers might improve their instruction, and thus identify developmentally appropriate next steps for individual teachers' improvement of their practice. Three papers featured examples of coaches eliciting teachers' reasoning about instruction (Gibbons, Kazemi, & Lewis, 2017; Haneda, Teemant, & Sherman, 2017; Olson & Barrett, 2004). In many ways, this coaching practice is analogous to the teaching practice of eliciting students' current thinking in order to plan subsequent instruction (see, e.g., Grossman, Hammerness, & McDonald, 2009). Similarly, coaches can elicit teachers' reasoning in order to identify developmentally appropriate next steps for them to improve their instruction, and thus plan how to support teachers' learning.

Haneda, Teemant, and Sherman (2017) illustrate this coaching practice in their analysis of a year-long one-on-one coaching intervention. The authors describe how a coach elicited a participating teacher's reasoning about an upcoming lesson in order to understand the teacher's pedagogical rationale. This rationale then informed the focus of the coach's work with the teacher. To elicit the teacher's rationale, the coach probed the teacher's reasoning during debrief conversations, asking the teacher questions about her instruction. The teacher's responses gave the coach an opportunity to understand how the teacher was thinking about her current practice. Based on the teacher's responses, the coach then made decisions about appropriate next steps for supporting the teacher to improve.

Olson and Barrett (2004) also illustrate this practice, describing how a focal coach asked a teacher questions about her instruction in order to better understand the teacher's pedagogical rationale. In doing so, the coach elicited the teacher's reasoning for her instructional decisions, which then informed the identification of next steps for that teacher's learning. In this case,

conversations with the teacher revealed that the teacher often modeled mathematics strategies for her students because, as the teacher put it, many students in her class would never figure out the math otherwise. Eliciting the teachers' rationale for her instructional decisions revealed "a belief that her students could not independently solve mathematical problems and that understanding was demonstrated by correct answers" (p. 69). As a consequence, the coach determined that it might be useful for the teacher to see her students engaged in a rigorous, inquiry-oriented lesson in order to problematize her current perspective.

In both of these illustrations, eliciting a teacher's rationale for his or her instructional decisions helped the coach understand a teacher's current instructional practices. This, in turn, helped coaches make decisions about appropriate next steps for the teachers' improvement of their instruction. In many ways, this coaching practice complements the practice of "observing classroom instruction to identify strengths and areas of improvement." For example, coaches might enact these two practices in concert by observing instruction and then engaging teachers in conversations about their instruction immediately following the observation. Doing so can enable coaches to learn about both a teacher's current practices and the underlying reasons for those practices.

Eliciting teachers' pedagogical reasoning likely implicates both an ambitious vision of instruction and a developmental perspective on teaches' learning. In the two cases outlined above, for example, the coaches elicited the teachers' reasoning and made sense of teachers' current instructional practices *in relation to* sophisticated forms of instruction that constituted the coaches' long-term goals for their teachers' learning. Engaging in this process involves coaches using their vision of high-quality instruction as a benchmark to locate a teacher's instructional rationale on an implicit trajectory that culminates with ambitious forms of instruction. This, in

turn, implicates a developmental perspective on teachers' learning, because it involves identifying strengths in teachers' current instruction on which to build as well as weaknesses that constitute areas for improvement, rather than focusing solely on gaps in teachers' knowledge that need to be remediated.

Function 2: Support teachers to connect instruction to students' thinking and learning in a given content area

A second key function in one-on-one coaching involves pressing and supporting teachers to relate their instruction to their students' thinking in a particular content area (e.g., Ball & Cohen, 1999; Cohen, Raudenbush, & Ball, 2003). Coaches can accomplish this function by engaging teachers in what Russell and colleagues (2016) have termed "deep and specific discussions" of pedagogy, students' thinking, and content (p. 9). Russell and colleagues argue that this practice is particularly meaningful when enacted in co-planning conversations. At the same time, two studies (e.g., Matsumura et al., 2019; Gibbons, Kazemi, & Lewis, 2017) indicate that this practice is central to other types of discussions, including post-observation feedback conversations between a teacher and a coach. Accomplishing this function in coaching can support teachers to "see and reason about the link between their instructional decisions" and "students' thinking" (Matsumura et al., 2019, p. 7), and thus consider the impact of their instructional decisions on their students' thinking and learning. This might, in turn, support teachers in developing increasingly sophisticated visions of high-quality instruction.

Engaging teachers in deep and specific conversations of pedagogy, students' thinking, and content. Three studies highlight the importance of this practice for accomplishing the aforementioned function (Gibbons, Kazemi, & Lewis, 2017; Russell et al., 2016). Russell

and colleagues (2016) indicate it is essential for coaches to engage teachers in deep and specific conversations of pedagogy, students' thinking, and content when *planning* lessons. Enacting this practice in planning involves unpacking "the underlying meaning of a… topic," discussing the "multiple solution paths that students could use to solve a task," and collaboratively identifying "the questions teachers could use to advance students' thinking" (Russell et al., 2016, p. 9). In conversations occurring after a lesson, enacting this practice might involve analyzing evidence of students' thinking alongside evidence of a teachers' instruction to reach conclusions about whether and how instruction supported students' learning, thereby supporting teachers in seeing connections between students' learning and instruction.

Gibbons, Kazemi, and Lewis (2017) illustrate how engaging teachers in deep and specific conversations of pedagogy, students' thinking, and content *after a lesson* can support teachers to see connections between instruction and students' thinking and learning. As noted previously, this coach worked with a group of teachers. As part of this work, the coach pressed the teachers to analyze a lesson they had taught together as a group. Doing so provided the participating teachers with opportunities to discuss the ideas their students developed over the course of the lesson, and then relate those ideas to the instructional decisions they had made in planning and enacting that lesson. Discussing these connections "was important in developing the group's knowledge base about children's thinking" (p. 16), which the authors argue is a first step in supporting the teachers to develop a shared vision of high-quality instruction.

I conjecture that enacting this coaching practice likely implicates a sophisticated vision of high-quality instruction, knowledge of content, and knowledge of students' thinking in a given content domain. For example, Gibbons and colleagues (2017) report that the coach in their study had extensive knowledge of students' learning in the focal content domain (in this case,

fractions), as well as a sophisticated vision of high-quality instruction. This knowledge of students' thinking likely informed how the coach facilitated the teachers' analysis of students' thinking. Similarly, the coach's sophisticated vision of high-quality instruction likely informed the extent to which the coach pressed teachers to connect their analysis of students' thinking to specific aspects of instruction.

Function 3: Orient teachers to students' current capabilities in a given content area

My analysis also indicates that high-quality coaching involves orienting teachers to students' current capabilities in a given content area (Olson & Barrett, 2004; Russell, 2015). Coaches can do so by providing teachers with opportunities to see their students engaging in ambitious instruction (Olson & Barrett, 2004), as well as by pressing teachers to consider the implications of instructional decisions for all the students in the classroom (Russell, 2015). However, I identified only one illustration for each of these practices, suggesting that the content-focused coaching literature has yet to make issues of equity in students' learning opportunities an explicit focus. As such, future research could investigate these and other coaching practices that focus closely on issues of equity.

Providing teachers with opportunities to see their students engaging in ambitious instruction. The first practice for orienting teachers to their students' current capabilities is "providing teachers with opportunities to see their students engaging in ambitious instruction." Olson and Barrett (2004) illustrate this practice. In their article, the coach modeled instruction in order to challenge a teacher's view that her students were incapable of participating productively in inquiry-oriented mathematics instruction. Prior to the modeled lesson, the coach explicitly directed the teacher to attend to how her students were engaging with the mathematics during the

model lesson. It appeared important that the coach modeled ambitious instructional practices with the teacher's own students rather than, for example, showing the teacher a video of other students engaged in rigorous mathematics instruction. This provided the teacher with the opportunity to investigate what *her* students were currently capable of doing when supported to engage in ambitious instruction.

Following the modeled lesson, the coach and teacher engaged in a deep and specific conversation about the relationship between the coach's instructional decisions, students' thinking, and the mathematical content. This indicates that the practice of engaging teachers in deep and specific conversations of pedagogy, students' thinking, and content connects with the practice of modeling instruction to support teachers in developing productive views of students' current capabilities in a content area. As noted later in my findings, four other papers describe cases in which a coach modeled instruction in order to support a teacher's implementation of key practices (e.g., Matsumura, Garnier, & Spybrook, 2012; Teemant, Wink, & Tyra, 2011). However, Olson and Barrett's case is the only illustration I found that highlights modeling as a strategy for supporting teachers to develop more productive views of their students' current capabilities. It therefore underscores the importance of attending not only to what coaches do but also to their purposes for doing it.

This coaching practice likely implicates productive views of students' current capabilities in a given content area. In this regard, I draw on an analysis of teachers' views of their students' current capabilities conducted by Jackson, Gibbons, and Sharpe (2017). This analysis focused on both 1) how teachers explain the source of students' difficulties when they do not learn as expected and 2) how teachers attempt to support the learning of students who are currently experiencing difficulties. Modeling instruction to challenge teachers' views of their students'

current capabilities requires that coaches see prior and current instruction as the primary source of students' difficulties, and that coaches respond to those difficulties by supporting students to participate in—and learn from—ambitious instruction. In addition, enacting this practice necessarily requires expertise in enabling students' equitable participation in ambitious instruction.

Pressing teachers to consider the implications of instructional decisions for all students in the classroom. The second practice for meeting this function involves coaches pressing teachers to consider the needs of all students in the classroom when making instructional decisions. Only one article explicitly referenced this coaching practice (Russell, 2015), again indicating the limited number of studies with an explicit focus on issues of equity in the coaching literature. In this article, Russell describes how a focal coach pressed a participating teacher to take account of the learning needs of all students by introducing specific differentiation strategies to ensure broad participation in science lessons. In doing so, the coach never conceded "to increasing the pace of the class without taking into account the needs of the [ELLs]" (p. 40). Thus, the coach oriented the teacher to students' current challenges but also pressed the teacher to address those challenges without lowering expectations for currently struggling students.

Enacting this practice likely implicates coaches' development of productive views of students' current capabilities in a particular content area. Specifically, this practice likely implicates the perspective that currently struggling students are capable of attaining rigorous learning goals if they are provided with additional support. Finally, enacting this practice effectively likely also requires that coaches have developed expertise in providing such support.

This expertise is likely necessary for coaches to actually support teachers in maintaining the rigor of their instruction for all students.

Function 4: Negotiate next steps for teachers' instructional improvement

The fourth function identified in my analysis involves coaches negotiating next steps for teachers' instructional improvement *with teachers*. I use the term "negotiate" to indicate that the intent is to achieve a consensus on immediate instructional improvement goals that individual teachers see as reasonable and that are consistent with coaches' assessments of those teachers' current instructional practices. Three articles reference the importance of negotiating next steps for teachers' instructional improvement (Haneda, Teemant, & Sherman, 2017; Olson & Barrett, 2004; Teemant, Wink, & Tyra, 2011); however, two of these articles do not provide clear illustrations of *how* a coach can effectively negotiate short- and long-term goals. For example, Teemant, Wink, and Tyra (2011) cite the importance of negotiating mutually acceptable goals, but do not describe how coaches in their study went about negotiating those goals with teachers. For their part, Olson and Barrett (2004) describe a goal-setting process but found that this process did not lead to a consensus between the coach and teacher. This latter example, while not clarifying how a coach can successfully negotiate improvement goals, does underscore the importance of attending to teachers' will and agency when supporting their development of ambitious instructional practices.

Eliciting and reframing teachers' problems of practice. Haneda, Teemant, and Sherman (2017) provide a clearer illustration of how coaches can negotiate improvement goals with teachers. In this case, a coach engaged an individual teacher in ongoing conversations in which the coach elicited and then reframed (rather than challenged or simply accepted) the

teacher's current thinking about instruction. As these conversations extended over the course of the school year, the coach drew on her sophisticated understanding of high-quality instruction to identify potential points of contact between the improvement goals she had identified and the problems of practice the teacher identified. This enabled the coach to legitimize the teacher's concerns but also allowed her to problematize aspects of the teacher's current instruction in ways consistent with the improvement goals she had identified

As this example demonstrates, negotiating goals is likely to involve give-and-take because the coach and teacher might well have different interpretations of reasonable next steps for improvement. The example also illustrates the importance of coaches acknowledging and then reframing teachers' current problems of practice. By doing so, coaches can guide the development of mutually acceptable goals for improvement. Reaching a consensus on improvement goals is likely essential if teachers are to sustain their efforts to improve their instruction, as teachers are unlikely to extend improvement efforts over time if they do not see the improvement goals as sensible (e.g., Olson & Barrett, 2004).

Coaches are likely to require a reasonably sophisticated vision of high-quality instruction if they are to negotiate short- and long-term goals with teachers. The process of negotiation also implies that coaches view teachers as primary agents in doing the improving. Additionally, negotiating improvement goals likely involves sophisticated interpersonal skills. These interpersonal skills might include making sense of teachers' current problems of practice and then working *with them* to find common ground. Finally, this practice builds on the practice of identifying developmentally appropriate next steps for teachers' learning. As such, this practice also likely implicates a developmental perspective on teachers' learning.

Function 5: Support teachers to improve their enactment of ambitious instructional practices

The fifth one-on-one coaching function identified in this analysis involves supporting teachers to improve their enactment of ambitious instructional practices with their students. To some extent, all of the previously described practices have this as an underlying purpose, as the eventual goal of coaching is to support improvements in instruction and thus student learning. However, the two practices associated with this function—providing in-classroom assistance and facilitating evidence-based discussions of teachers' instructional practice—address this purpose directly. Both practices involve a teacher working with a coach to solve problems of implementation in order to improve teaching, and are thus grounded directly in either teachers' instructional practice or evidence of that practice.

Providing in-classroom assistance in response to the challenges of enacting specific instructional practices effectively is one of the most common coaching practices described in the coaching literature. Five papers explicitly mention coaches enacting some form of in-classroom assistance (Hindman & Wasik, 2012; Matsumura, Garnier, & Spybrook, 2012; Olson & Barrett, 2004; Polly, 2012; Russell, 2015), such as pausing instruction to discuss teaching, modeling an instructional strategy for a teacher, or asking a question as a student. In each of these cases, the coach supports the teacher to improve her enactment of particular instructional practices. In some instances, the form of the assistance is similar to that outlined when discussing previous practices (e.g., modeling). However, here the function of the assistance is to support teachers in implementing ambitious practices effectively. Again, this highlights the importance of attending not merely to coaches' observable actions but to the purpose of those actions.

Providing in-class assistance: modeling instruction. Four of the five papers reference modeling as a form of in-class assistance that proved useful for supporting teachers to develop ambitious instructional practices (Hindman & Wasik, 2012; Matsumura, Garnier, & Spybrook, 2012; Olson & Barrett, 2004; Polly, 2012). In each of these cases, the coach modeled instruction as an early step in scaffolding individual teachers' enactment of ambitious instructional practices. For example, Hindman and Wasik (2012) note that, after first introducing teachers to new instructional strategies in pull-out professional development, coaches "visited each teacher's classroom to model the instructional strategies targeted in the workshop" (p. 136). Teachers completed a checklist while the coach modeled the strategy, with the goal of helping teachers attend to key aspects of the modeled strategy. This case illustrates that one purpose of modeling is to support teachers' development of an image of particular instructional practices prior to attempting to enact the practices in their classrooms.

Enacting this practice implicates a coach's capacity to enact ambitious and equitable instructional practices with students. For example, modeling ambitious instruction likely involves being able to enact those practices in a reasonably accomplished manner. Further, effectively modeling ambitious instruction likely also involves an understanding of content and students' thinking in a content area, as these ways of knowing are implicated in the enactment of ambitious instructional practices.

Providing in-class assistance: co-teaching. Three papers also illustrate how coaches can support teachers' attempts to enact particular practices by co-teaching lessons with them (Matsumura, Garnier, Spybrook, 2012; Olson & Barrett, 2004; Polly, 2012). These findings echo the findings of a conceptual analysis by Gibbons and Cobb (2017) that identified potentially productive types of coaching activities. In this analysis, Gibbons and Cobb posit that co-teaching

can support teachers in learning to enact particular practices. Initial evidence from the coaching literature appears to substantiate this conjecture.

As a supplement to more formal co-teaching, two articles indicate that coaches can support teachers to develop ambitious instructional practices by asking or answering questions as "students" (e.g., Polly, 2012) or providing "on-the-fly suggestions and check-ins" (Russell, 2015, p. 35) during teachers' instruction. In both of these cases, the coach intervened to support the participating teachers' enactment of ambitious instructional practices. Unlike formal co-teaching, these interactions feature the coach serving as a just-in-time support without participating fully as a classroom teacher. For example, Polly (2012) notes that many of his teachers asked him to "look at specific students' work and discuss students' error patterns" during the lesson. In doing so, he was able to provide feedback that had the potential to influence the quality of instruction in both the current lesson and in subsequent lessons.

As noted immediately prior, Polly describes how teachers asked him to analyze student work during a lesson to inform their enactment of instruction. This indicates that responding to the challenges of implementing ambitious and equitable instructional practices likely implicates coaches' knowledge of students' thinking and learning in a content area. Finally, coaches likely draw on their sophisticated visions of high-quality instruction when they identify occasions where in-class support is appropriate during co-teaching. For example, knowing *when* to ask or answer questions as a "student" during a lesson might involve a coach drawing on his or her instructional vision as a benchmark to determine moments in a lesson when the teacher is struggling to enact particular practices or has missed an opportunity to enact a key practice. The coach could then frame these moments as opportunities for teacher learning and interject accordingly.

Again, enacting this practice implicates a coach's capacity to enact ambitious and equitable instructional practices with students. Further, it also likely involves an understanding of content and students' thinking in a content area, as these ways of knowing are implicated in the enactment of ambitious instructional practices.

Facilitating evidence-based discussions of teachers' instructional practice. Five articles illustrate how coaches can respond to problems of implementation by facilitating evidence-based discussions of teachers' instructional practice (Garet et al, 2016; Haneda, Teemant, & Sherman, 2017; Matsumura et al., 2019; Russell et al., 2016; Teemant, Wink, & Tyra, 2011). This coaching practice involves a bi-directional feedback process in which the coach and teacher actively engage in discussions of the teachers' instruction that are grounded in evidence from teachers' classrooms, with an eye towards identifying strengths and weaknesses, and thus improvements the teacher might make. Russell and colleagues (2016) note that there is value in analyzing evidence that "attends to both the teachers' pedagogy and students' [thinking and learning]" (p. 10). Though these conversations likely involve discussions of pedagogy, students' thinking, and content, the explicit focus is on problems of implementation, rather than supporting teachers' to see *connections between* instruction and students' learning. This focus on implementation distinguishes this practice from other, similar practices.

As an illustration of this practice, Haneda, Teemant, and Sherman (2017) describe how a coach used a running record from a classroom observation as evidence of the participating teacher's enactment of key instructional strategies with her students. The authors note that the coach made an explicit attempt to position the teacher in an "agentive role" during these collaborative analyses, indicating that the evidence-based discussions were bi-directional, and not just prescriptions from the coach. In doing so, the coach supported the teacher to identify the

aspects of her teaching that "contributed to her kindergartener's high engagement," and thus what the teacher should continue to do.

Two studies (Garet et al., 2016; Matsumura et al., 2019) describe how coaches can work with teachers to collaboratively analyze video-recordings of instruction in order to identify how a teacher might improve her enactment of key instructional practices. For their part, Garet and colleagues do not explicitly articulate how coaches can facilitate these conversations effectively. However, Matsumura and colleagues illustrate how coaches can facilitate evidence-based discussions using classroom video. In their study, the authors found that facilitating these types of discussions effectively involves "the use of non-evaluative language" when discussing classroom video, positioning individual teachers as capable of doing "their own analysis" of their instruction, and focusing on strengths in the lesson "as well as areas for growth" (p. 20). Further, Matsumura and colleagues note that teachers in their study found it helpful to view and reflect on classroom video privately, prior to discussing video from a lesson with their coach.

Enacting this coaching practice effectively likely involves coaches' knowledge of how students' thinking progresses in specific content areas, as well as an ambitious and equitable vision of high-quality. For example, knowing how students' thinking progresses in a content area is necessary to identify and productively discuss evidence of students' thinking and learning (e.g., student work). Finally, facilitating evidence-based discussions of teachers' instructional practice also likely implicates the perspective that teachers should be positioned as primary agents in improving their instruction. Absent this perspective, a coach might simply tell teachers what to do differently based on his or her analysis of evidence from the classroom, an approach that runs counter to research on productive feedback.

Discussion

In this study, I identified a set of nine one-on-one coaching practices that integrate the *activities* coaches can enact to support teachers' development of high-quality instructional practices, the *purposes* behind those tasks and activities, and the *knowledge* and *perspectives* involved in enacting the types of activities effectively with teachers. I found that these nine practices serve five distinct functions in one-on-one coaching.

By identifying these nine practices, I further clarify the range of purposes that particular coaching activities can serve in supporting teachers' learning, thereby furthering our understanding of when and why coaches might enact particular activities with teachers. For example, I found that modeling instruction can serve different purposes, from supporting teachers to develop an image of a particular teaching practice to providing teachers with opportunities to see their students engaged in and learning from ambitious instruction. Therefore, coaches might choose to model instruction in an effort to problematize teachers' current conceptions of their students' current capabilities to learn in and from ambitious instruction (e.g., Olson & Barrett, 2004). On the other hand, a coach might model instruction with an individual teacher in order to support the teacher's development of an increasingly sophisticated image of high quality instruction. In specifying these overarching purposes of particular activities, my analysis further illustrates what high-quality one-on-one coaching looks like in practice.

The coaching practices identified in this analysis can also serve as provisional goals for coaches learning. Framing specific practices as goals for coach learning parallels approached to teacher education that treat specific instructional practice as goals for teachers' learning (e.g., Ball & Forzani, 2011; Grossman et al., 2009; Grossman & McDonald, 2008; McDonald, Kazemi, & Kavanagh, 2013). Further, much as teachers require significant support if they are to

develop ambitious practices, coaches require substantial support if they are to develop the coaching practice identified in this analysis. These practices therefore lay the groundwork for investigations of *supports for* coaches' learning. Such investigations might, for example, delineate trajectories for coach learning based on the identified coaching practices. These investigations might involve researchers partnering with district leaders to design supports for coach learning organized around a conjectured sequence of learning goals. Analyses of coaches' actual learning could then inform revisions to both the learning trajectory and design for supporting the coaches' development.

Future research might also investigate issues specific to the functions and practices identified in this analysis. For example, few studies have examined how coaches can effectively negotiate short- and long-term improvement goals with teachers. As noted previously, only one study in this analysis described a process for negotiating instructional improvement goals (Haneda, Teemant, & Sherman, 2017). However, my analysis did identify negotiating goals as a key function of one-on-one coaching (e.g., Olson & Barrett, 2004; Teemant, Wink, & Tyra, 2011). Of note, I did find a study in the coaching literature that illustrates approaches to discussing goals with teachers (Robertson et al., 2019); however, this study did not meet my criteria for inclusion, in that it did not include evidence of teachers' development of ambitious instructional practices. Further research is therefore needed to better understand how coaches can effectively negotiate improvement goals with teachers. The practices identified in the findings of this study could be a starting point for investigating these processes.

Additionally, researchers might also investigate how mathematics coaches can support teachers' development of more productive views of their students' current capabilities in a given content area. As noted previously, very few of the studies in this analysis focused on supporting

teachers to see their students as capable of participating in ambitious instruction. Although I identified two practices for orienting teachers to their students' capabilities, the empirical warrant for these practices is thin. Further research related to these practices is therefore necessary.

Finally, my analysis of the literature identified only eleven studies that met my criteria for high-quality one-on-one coaching. As such, it is possible that my findings omit key practices specific to one-on-one coaching. Further, because the studies on which I drew focused on coaching in a range of different subject matter areas, it is possible that my findings omit key practices specific to coaching in *particular content domains*. This indicates a need for additional studies that seek to clarify the aspects of high-quality one-on-one coaching in various subject matter areas.

In conclusion, the findings of a number of studies indicate that coaching has the potential to support teachers to make improvements in their instruction (e.g., Blazar & Kraft, 2015; Matsumura, Garnier, & Spybrook, 2012; Teemant, Wink, & Tyra, 2011). However, research also indicates that the effectiveness of coaching depends, in part, on the quality—as well as the amount—of coaching that teachers receive (Atteberry & Bryk, 2011). With this in mind, I analyzed the coaching literature to identify coaching practices for which there is evidence that they support teachers' development of ambitious instructional practices. In specifying these practices, I further clarify when and why coaches might enact particular types of coaching activities with teachers, as well as the knowledge and perspectives involved in enacting those activities effectively with teachers. In doing so, I outline provisional goals for supporting teachers' learning.

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CHAPTER III

IDENTIFYING AND NEGOTIATING PRODUCTIVE INSTRUCTIONAL IMPROVEMENT GOALS IN ONE-ON-ONE MATHEMATICS COACHING

Introduction

Currently, states across the country are implementing new standards that outline more rigorous goals for students' learning (e.g., Peterson Barrows, & Gift, 2016; Stage, Asturias, Cheuk, Daro, Hampton, 2013). In mathematics, these goals center on students' development of conceptual understanding, procedural fluency, and mathematical practices (e.g., constructing mathematical arguments, critiquing the reasoning of others). Educational researchers have identified the types of mathematics lessons that can support students in attaining rigorous learning goals. These inquiry-oriented lessons are organized around cognitively demanding tasks (Stein, Grover, & Henningsen, 1996; Stein & Lane, 1996) and typically feature three phases: introducing cognitively demanding tasks, engaging students in small group or independent work time, and facilitating concluding whole class discussions (e.g., Lappan, Fey, Fitzgerald, Friel, & Phillips, 2009; Van de Walle, 1998). Additionally, mathematics education researchers have reached an empirically grounded consensus on the types of *ambitious instructional practices* involved in enacting these lessons effectively (e.g., Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010; Lampert & Graziani, 2009). These practices include selecting cognitively demanding mathematics tasks (Stein, Grover, & Henningsen, 1996; Stein & Lane, 1996), introducing tasks so that all students can begin working productively without lowering the cognitive demand (Jackson, Shahan, Gibbons, & Cobb, 2012), and facilitating mathematics

discussions in which teachers press and support students to explain their reasoning and make connections between different solution strategies (Kazemi & Stipek, 2001; Stein, Engle, Smith, & Hughes, 2008).

For many mathematics teachers, these forms of instruction differ significantly from their current instructional practices. For these teachers, designing and implementing mathematics lessons that can support students in attaining rigorous learning goals will require significant shifts in their instructional practices (e.g., Wood, Cobb, & Yackel, 1991). This professional learning requires sustained, job-embedded support (Cohen & Hill, 2001; Darling-Hammond & Richardson, 2009). There is increasing evidence that one-on-one, content-focused coaching can support teachers' learning when coaching is enacted well (Kraft, Blazar, & Hogan, 2018; Matsumura, Garnier, & Spybrook, 2012; Teemant, Wink, & Tyra, 2011). With this in mind, this study focuses on one-on-one mathematics coaching as a strategy for supporting mathematics teachers in developing the ambitious instructional practices involved in enacting inquiry-oriented mathematics lessons effectively.

Prior research on coaching has identified the types of potentially productive one-on-one coaching activities that can support teachers' learning when enacted effectively, such as co-teaching, modeling, and one-on-one coaching cycles (Gibbons & Cobb, 2017; Russell et al., 2017; Teemant, Wink, & Tyra, 2011). These findings can inform the design of mathematics coaching initiatives by indicating how coaches should spend their time when working with teachers. Prior research has also begun to specify what coaches need to know and be able to do to enact potentially productive coaching activities effectively with teachers (e.g., Bengo, 2016; Gibbons & Cobb, 2016; Haneda, Teemant, & Sherman, 2017; Hindman & Wasik, 2012; Olson & Barrett, 2004; Russell, 2015; Russell et al., 2016; Russell et al., 2017; Robertson et al., in

press). Evidence from this line of research indicates that enacting one-on-one coaching activities effectively with teachers includes identifying productive goals for individual teachers' improvement of their instructional practices (Gibbons & Cobb, 2016; Olson & Barrett, 2004).

As described later in this study, I define *productive* instructional improvement goals as goals that a) are feasible for individual teachers to attain given adequate support, and b) will result in improvements in students' learning, if attained. Identifying productive goals is important because these goals inform when and why coaches engage teachers in particular types of coaching activities (Gibbons & Cobb, 2016). Identifying goals specific to teachers' current practices also enables coaches to individualize their work with teachers, which is an essential component of one-on-one coaching (Bengo, 2016).

And yet, identifying productive instructional improvement goals is not enough to ensure that one-on-one mathematics coaching is effective in supporting teachers' learning. Prior research also indicates that it is essential for teachers to see improvement goals as reasonable and worth pursuing if they are to engage in the challenging work of reorganizing their current instructional practices (Atteberry & Bryk, 2011; Cobb et al., 1991). To this end, it is essential that teachers have a voice in determining improvement goals if they are to come to see particular improvements as reasonable (Robertson et al., in press; Haneda, Teemant, & Sherman, 2017). It is therefore essential that mathematics coaches also negotiate instructional improvement goals with teachers (Robertson et al., in press; Haneda, Teemant, & Sherman, 2017). Identifying and negotiating improvement goals appear to be closely related, with coaches taking the goals they have identified as a starting point for negotiating improvement goals with teachers.

Though these two aspects of coaching practice are essential to supporting teachers' learning, the current coaching literature provides limited empirical guidance regarding *how*

mathematics coaches can identify productive instructional improvement goals and, on that basis, negotiate productive goals successfully with teachers. The primary goal of this study was to address these two gaps in the literature by examining the processes by which a cohort of middle grades mathematics coaches identified and, on that basis, negotiated instructional improvement goals with teachers. As I describe below, I investigated these two issues in the context of a year-long professional development (PD) design study aimed at supporting middle-grades mathematics coaches in enacting one-on-one coaching cycles effectively with teachers. Evidence in the coaching literature indicates that enacting coaching cycles effectively involves both identifying and negotiating instructional improvement goals (Teemant, Wink, & Tyra, 2011; Robertson et al., in press; Russell et al., 2016). To this end, the objectives of the coach PD included supporting the participating mathematics coaches in first identifying productive instructional improvement goals and then negotiating productive goals successfully with teachers. The coach PD was therefore an appropriate context for investigating these issues.

In what follows, I first define productive instructional improvement goals in mathematics coaching. Next, I review the literature related to identifying and negotiating instructional improvement goals in one-on-one coaching. I then specify my research questions. Following that, I further describe the context in which I investigated my questions and specify my methods for investigating my questions. I then report on the findings from my analysis. Finally, I discuss the significance of my findings for research on coaching.

Productive Instructional Improvement Goals in One-on-One Mathematics Coaching

As mentioned previously, I define productive instructional improvement goals as specific improvements in instruction that a) are feasible to attain if teachers receive adequate support, and

b) will better support students in attaining rigorous learning goals. By feasible to attain, I mean that the goals constitute immediate next steps in teachers' development, and thus build from and are grounded in individual teachers' current ways of teaching. By better support students in attaining rigorous learning goals, I mean that attaining the goal involves the development of ambitious instructional practices that will improve students' learning opportunities.

It is important to clarify that not all ambitious instructional practices constitute productive improvement goals at a particular point in a teacher's development. This is because the structure of inquiry-oriented mathematics lessons has implications for the extent to which teachers' attainment of particular improvement goals will, in all likelihood, enhance students' learning. As outlined previously, inquiry-oriented mathematics lessons are organized around cognitively demanding tasks and feature three phases: the introduction of the task(s), students' work time, and concluding whole class discussions. In this lesson structure, students' opportunities to learn in later phases *depend on* the quality of prior phases. For example, supporting students' learning during whole class discussions involves teachers pressing students to make connections between different solution strategies (Stein, Engle, Smith, & Hughes, 2008). The possibility of conducting a productive whole class discussion therefore depends on whether students actually solved tasks in a variety of different ways during independent or small group work time. This, in turn, depends on whether teachers select cognitively demanding tasks that afford a range of solution strategies (e.g., Stein, Grover, & Henningsen, 1996; Stein & Lane, 1996; Smith & Stein, 2011), and then launch tasks in ways that enable all students to begin working productively but without prescribing a set solution strategy (Jackson, Shahan, Gibbons, & Cobb, 2012).

Given these interdependencies, it is possible that working to develop particular instructional practices that are justifiable given research on ambitious teaching might prove

unproductive given teachers' current enactment of prior lesson phases. For example, it would not be productive to work with a teacher to improve how a teacher presses students to make connections between different solution strategies during whole class discussions *unless* the teacher has selected cognitively demanding tasks and launched the tasks effectively. This underscores the importance of coaches identifying *productive* goals, if they are to work with teachers in ways that can actually result in improvements in students' learning. I next review what is currently known about how mathematics coaches can identify productive goals for mathematics teachers' improvement of their instructional practices. I then also review what is known about how coaches can negotiate goals effectively with teachers.

Literature Review

Identifying Productive Instructional Improvement Goals

Findings in the coaching literature indicate that identifying goals for teachers' improvement of their instructional practices is a key aspect of one-on-one coaching (e.g., Gibbons & Cobb, 2016; Teemant, Wink, & Tyra, 2011). However, prior research provides only limited guidance regarding the processes by which coaches can identify *productive* instructional improvement goals. Scholars describe coaching programs in which coaches identify goals based on *teachers'* assessments of their current practices and students' learning (Sailors & Price, 2015; Knight, 2007, 2009). In general, this approach is justified on the grounds that teachers are professionals, and coaches should therefore aim to support teachers in attaining the goals they set for themselves. However, this approach ignores coaches' intended role as more accomplished others, and thus the rationale for one-on-one coaching. Further, this approach assumes that

teachers have already developed sophisticated visions of high-quality mathematics instruction and can self-asses their progress in developing the kinds of instructional practices that can support students in attaining rigorous learning goals. While some mathematics teachers have developed these capabilities, they are the exception rather than the rule in most schools and districts (Cobb, Jackson, Henrick, Smith, & the MIST team, 2018).

In contrast, other scholars suggest that coaches should identify goals based on school-wide, district-wide, or program-specific priorities (e.g., Haneda, Teemant, & Sherman, 2017; Killion, 2010; Teemant, Wink, & Tyra, 2011). This approach can, in some circumstances, result in coaches aiming to support teachers' development of research-based instructional practices. However, it does not take account of teachers' current practices and their students' current learning opportunities. As a consequence, this approach overlooks an important affordance of one-on-one coaching—that coaches can tailor improvement goals to teachers' current practices and classroom contexts.

A more productive alternative to these two approaches involves identifying improvement goals specific to teachers' current practices. My review of the coaching literature found only one empirical study that closely examined how mathematics coaches can identify goals for individual teachers' improvement of their instructional practices (e.g., Gibbons & Cobb, 2016). In this study, the authors analyzed the planning practices of an accomplished mathematics coach who routinely engaged individual teachers in potentially productive coaching activities. As part of their analysis, the authors found that the focal coach identified teacher learning goals by 1) observing and assessing individual teachers' current instructional practices by relating evidence of instruction with evidence of students' learning and 2) comparing teachers' current practices with the coach's vision of high-quality instruction in order to locate individual teachers'

practices along "general trajectories" that the coach had "delineated for novice and veteran teachers' learning" (p. 251). These findings mark a significant contribution to the coaching literature by outlining how mathematics coaches can identify attainable instructional improvement goals justified in terms of teachers' current practices.

However, Gibbons and Cobb relied on interviews with the focal coach and did not observe how the coach actually attempted to support individual teachers' learning. As a consequence, the authors described the focal coach's self-reported process for identifying goals but were unable to closely examine the actual processes by which the coach identified improvement goals for particular teachers in particular cases. Further, this study did not closely examine whether and, if so, how the focal mathematics coach identified goals that were both feasible *and* would better support students in attaining rigorous learning goals, if attained. There is thus a need to better understand how mathematics coaches can identify *productive* instructional improvement goals that meet both of my criteria, as doing so is a critical aspect of one-on-one coaching.

Negotiating Productive Instructional Improvement Goals

In addition to identifying goals for teachers' improvement of their instructional practices, it is also essential that coaches negotiate improvement goals with teachers, thereby supporting them in coming to see productive instructional improvement goals as worth pursuing. By negotiate goals with teachers, I mean engaging teachers in multivocal conversations in which the teacher and the coach each have a say in the establishment of an improvement goal. Multivocal conversations contrast with univocal goal-setting conversations in which the coach either accepts the improvement goals the teacher has identified at face value or prescribes an improvement goal

without attending to the teacher's views on the matter. Similar to identifying productive instructional improvement goals, the current coaching literature provides limited guidance regarding the process by which coaches can negotiate goals effectively with teachers, and thus support teachers in coming to see agreed-upon instructional improvement goals as worthwhile.

In a large-scale analysis of literacy coaching, Atteberry and Bryk (2011) acknowledged that the effectiveness of one-on-one coaching depends, in part, on the extent to which coaches foster teachers' will and agency to improve particular aspects of their instruction. This speaks to the underlying aims of effective negotiations. However, Atteberry and Bryk did not clarify how coaches can support teachers in developing the will and agency to pursue productive instructional improvement goals. At the same time, a small but increasing number of scholars have proposed that coaches should determine improvement goals in conjunction *with* teachers (e.g., Haneda, Teemant, & Sherman, 2017; Robertson et al., in press; Russell et al., 2017; Teemant, Wink, & Tyra, 2011), indicating the importance of ascribing agency to teachers and establishing teachers' buy-in to improvement efforts. However, of these scholars, only Haneda, Teemant, & Sherman (2017) and Robertson et al. (in press) closely examined the processes by which coaches and teachers determined goals together.

In their study, Haneda, Teemant, and Sherman described how an accomplished literacy coach supported an individual teacher in coming to see particular improvements as worth pursuing. They reported that the coach engaged the teacher in ongoing "dialogues" that appeared to be multivocal in which the coach elicited and then reframed (rather than challenged or accepted) the teacher's current ways of thinking about instruction. Over the course of these ongoing dialogues, the coach supported the teacher in coming to see the value of the goals the coach had identified. This study contributes to our understanding of goal-setting negotiations by

indicating that effective negotiations are multivocal and involve eliciting and pressing on teachers' current problems of practice, thereby giving the teacher voice in determining instructional improvement goals. However, the coaching program that Haneda and colleagues studied aimed to support teachers in incorporating a pre-determined set of practices into their current instructional routines. As a consequence, the authors did not consider the extent to which the aforementioned goal-setting dialogues resulted in improvement goals that were feasible to attain and would improve students' learning, if attained.

Similarly, Robertson and colleagues (in press) closely examined the ways in which five literacy coaches established improvement goals with teachers. In this study, the authors identified "four discourse actions" that were characteristics of goal-setting interactions that resulted in teachers acting on—or taking up—the agreed upon improvement goals. These discourse actions include: "opening the floor through elicitations and affirmations, seeking further clarification, noticing and naming existing teaching behaviors as the foundation for new or refined behaviors, and providing expansions of strategic pedagogical knowledge" (p. 16). This study takes a significant step toward clarifying key characteristics of effective goal-setting conversations. However, as with Haneda, Teemant, and Sherman's study, the authors did not address whether the agreed upon goals would actually result in improvements in students' learning, and thus were productive.

In summary, my review of the coaching literature identified only two studies that examined the processes by which coaches might negotiate goals with teachers. Taken together, these studies indicate that negotiating goals involves eliciting, taking seriously, and building upon individual teachers' problems of practice (e.g., Robertson et al., in press), as well as pressing on and reframing those problems of practice based on the goals that coaches have

previously identified for teachers' improvement of their instruction (e.g., Haneda, Teemant, & Sherman, 2017). However, neither of these studies examined whether the negotiations resulted in improvement goals that a) were feasible to attain given adequate support and b) would better support students in attaining rigorous learning goals, if attained. Further, both studies investigated goal-setting negotiations in literacy coaching. Therefore, further research is needed that builds on these studies to understand how mathematics coaches can negotiate productive goals successfully with mathematics teachers, thereby supporting individual mathematics teachers in coming to see *productive* instructional improvement goals as worth pursuing.

Research Questions

The primary goal of this study was to clarify how mathematics coaches can identify productive instructional improvement goals and, on that basis, negotiate productive goals with teachers. The following research questions guided my effort to clarify these two processes:

1. *How can mathematics coaches identify productive goals for individual teachers' improvement of their instructional practices?*
2. *How can mathematics coaches then negotiate instructional improvement goals with teachers, such that coaches and teachers agree upon a productive goal?*

Research Context: Coach Professional Development Design Study

I investigated the aforementioned research questions by examining data collected as part of a professional development (PD) design study that aimed to support mathematics coaches in enacting one-on-one coaching cycles effectively with teachers. It would be challenging to investigate these two issues by conducting an observational study because it is likely that only a

small minority of mathematics coaches are currently identifying and negotiating productive instructional improvement goals effectively on their own. Two of the primary objectives of the design study included supporting coaches in identifying productive instructional improvement goals and then negotiating goals productively with teachers as part of their coaching cycles with teachers. The PD design study is therefore an appropriate context for this analysis because it aimed to support the participating coaches in accomplishing these two tasks effectively.

Overview of Coach Professional Development Design Study

Because the literature on supporting mathematics coaches' learning is thin, a researcher team (of which I was a member) partnered with mathematics instructional leaders in a large urban school district to conduct a design study that aimed to support middle-grades mathematics coaches in enacting one-on-one coaching cycles effectively with teachers. In the design study, the researchers and district leaders collaboratively designed and facilitated a sequence of eight monthly coach PD sessions across a school year. We organized each of the sessions around a key aspect of coaching practice central to enacting one-on-one coaching cycles effectively.

As elaborated below, enacting coaching cycles effectively involves both identifying and negotiating productive instructional improvement (e.g., Russell et al., 2017; Robertson et al., in press; Teemant, Wink, & Tyra, 2011). With this in mind, the objectives of the PD design study included support for mathematics coaches in identifying productive goals for individual teachers' improvement of their instructional practices and negotiating goals productively with teachers. Specifically, the second session of the PD focused on identifying productive instructional improvement goals effectively. The third session focused on negotiating goals with teachers. (See Appendix A for the full list of sessions.)

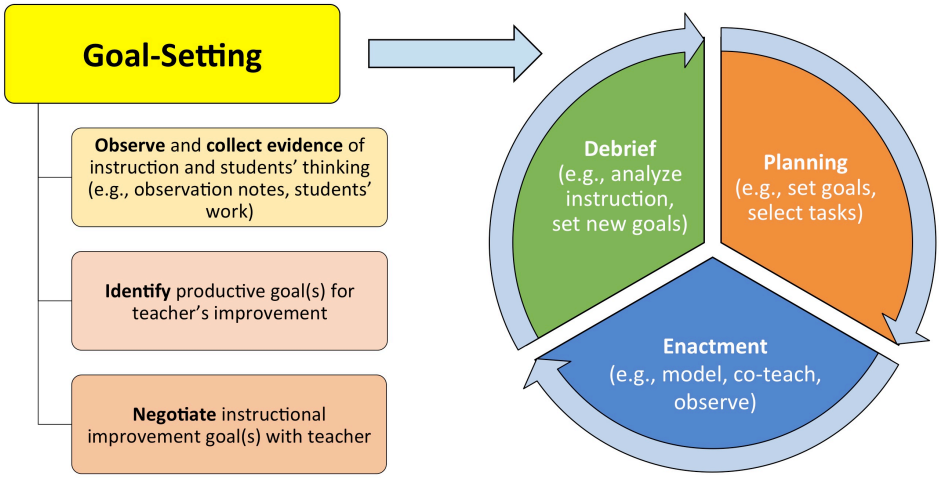
Participants. Fifteen school-based mathematics coaches participated in the coach PD design study. As part of the PD design, we asked each of the participating coaches to enact a coaching cycle with the same focal teacher after each of the eight sessions. Our intention in doing so was to provide the coaches with an opportunity to try out the ideas discussed in the PD sessions. We also collected data to document seven of the 15 participating coaches' practices as they enacted coaching cycles over the course of the school year. We did so in order to track the development of coaches' practices in relation to our goals for their learning. We selected these seven coaches in order to represent a range in coaching experience. Four were novice coaches in their first year of coaching, two coaches had extensive experience coaching in the district, and one coach had multiple years of experience in the role, but was new to the district.

In the section that follows, I discuss one-on-one coaching cycles in greater detail, because enacting one-on-one coaching cycles effectively served as the overarching goal for the coach PD, and thus directly informed our data collection efforts. In doing so, I illustrate how identifying and negotiating goals are two aspects of coaching practice central to enacting coaching cycles effectively with teachers.

Overarching Goal: Enacting One-on-One Coaching Cycles Effectively. As they are typically described in the literature (e.g., West & Staub, 2003), one-on-one coaching cycles consist of three phases: 1) a lesson planning phase, 2) a lesson enactment phase, and 3) a lesson debrief phase (see Figure 1, below). However, it essential that the coach and teacher have identified and agreed upon an instructional improvement goal prior to beginning a cycle, as the agreed upon goal orients their work in each of the three phases (Russell et al., 2016; Russell et al., 2017; Teemant, Wink, & Tyra, 2011). Preparing for the first coaching cycle with individual teachers therefore involves identifying and negotiating productive instructional improvement

goals *prior to* the full cycle. As part of the design study, we supported coaches to accomplish this by engaging in an initial goal-setting process (Figure 1, below). This process included the following steps: 1) observe and collect evidence of students' learning and the teacher's instruction, 2) identify productive instructional improvement goals based on that evidence, and 3) on that basis, negotiate an instructional improvement goal with the teacher.

Figure 1: Goal-Setting Process and One-on-One Coaching Cycle



Having engaged in the initial goal-setting process, and thus determined instructional improvement goals, coaches and teachers then engage in the full coaching cycle. In the lesson planning phase, the coach and teacher revisit previously agreed upon instructional improvement goals, determine student learning goals for the focal lesson, select instructional tasks consistent with those learning goals, and then work together to plan for the teacher's enactment of the lesson while paying particular attention to the changes in instruction necessary to make progress toward the agreed upon instructional improvement goal (Russell et al., 2016; Russell et al., 2017). Russell et al.'s (2016) findings indicate that facilitating planning conversations effectively

involves engaging teachers in "deep and specific discussions" that link mathematical learning goals, students' thinking, and instruction (p. 9). This therefore served as our goal for supporting coaches in planning effectively with teachers.

The lesson enactment phase involves the teacher implementing the planned lesson with students. As it is typically described in the literature, this phase involves the coach observing the focal lesson and collecting evidence of students' thinking and instruction while the teacher enacts the focal lesson (West & Staub, 2003). However, following Campbell & Malkus (2014), we also supported coaches to incorporate two other potentially productive one-on-one coaching activities, modeling and co-teaching, into this phase. Preparing for this phase effectively therefore involves determining when it is appropriate to model, co-teach, or collect evidence of instruction and students' thinking, based on agreed upon improvement goals.

In the debriefing phase, the coach and teacher analyze the implementation of the co-planned lesson. Matsumura and colleagues (2019) argue that facilitating debriefing conversations effectively involves supporting teachers to analyze evidence of students' learning and instruction in relation to the student learning goals of the focal lesson. In line with effective formative assessment practices (e.g., Wiliam & Black, 1996), the goal of this analysis is to analyze instruction in order to explain *why* students' learned what they actually learned in the lesson, and thus identify instructional strengths and weaknesses. In the course of this analysis, coaches and teachers revisit the agreed upon instructional improvement goal to determine whether teachers have made progress toward the improvement goal. If teachers have made progress, then the coach initiates a negotiation of a new instructional improvement goal.

Therefore, debriefing the lesson effectively involves negotiating instructional improvement goals with teachers, when appropriate. As such, preparing for the debrief phase

effectively involves the coach identifying a productive instructional improvement goal after the classroom instruction phase but prior to the debriefing phase. This goal then informs coaches' negotiations with teachers. With this in mind, we supported the participating coaches in identifying productive instructional improvement goals after the classroom instruction phase and to negotiate goals with teachers during the debriefing phase. For the purposes of this analysis, this means that coaches' initial goal-setting processes *and* their subsequent coaching cycles are both appropriate contexts for investigating how the coaches identified and negotiated productive instructional improvement goals with individual teachers.

Supporting Coaches to Identify and Negotiate Productive Goals Successfully. In the coach PD, we supported coaches to identify productive instructional improvement goals by first asking themselves two questions: 1) Were all students able to work meaningfully on the task(s)? And, 2) Was the range of student strategies rich enough to for the teacher to conduct a productive whole class discussion of students' solutions? We intended for coaches to answer these two questions by analyzing the evidence they had collected during their observations of the focal lessons in coaching cycles. Answering in the negative to either or both of these questions oriented coaches to identify improvement goals that centered on lesson phases prior to concluding whole class discussions, such as the introduction (or launch) of tasks. It also oriented coaches to consider the cognitive demand of the mathematics tasks. Conversely, answering in the positive to both of the questions oriented coaches to focus on improvement goals related to facilitating whole class discussions effectively, such as sequencing students' strategies so that mathematically significant issues come to the fore.

In addition to identifying productive goals, we also supported coaches to negotiate goals with teachers effectively. We did so by introducing coaches to a three-step process. In the first

step of this process, the coach asks the teacher to explain what went well in the lesson and what the teacher hoped to improve, thereby eliciting the teacher's interpretation of instructional strengths and weaknesses, as well as the teacher's improvement goals. The second step involves the coach reframing and building upon the teacher's proposed improvement goal to find common ground on an agreed upon improvement goal that the individual teacher would see as worthwhile and that would be compatible with the productive goal(s) previously identified by the coach. In the third step, the coach and teacher make a commitment to work toward the agreed upon improvement goal in their subsequent work together.

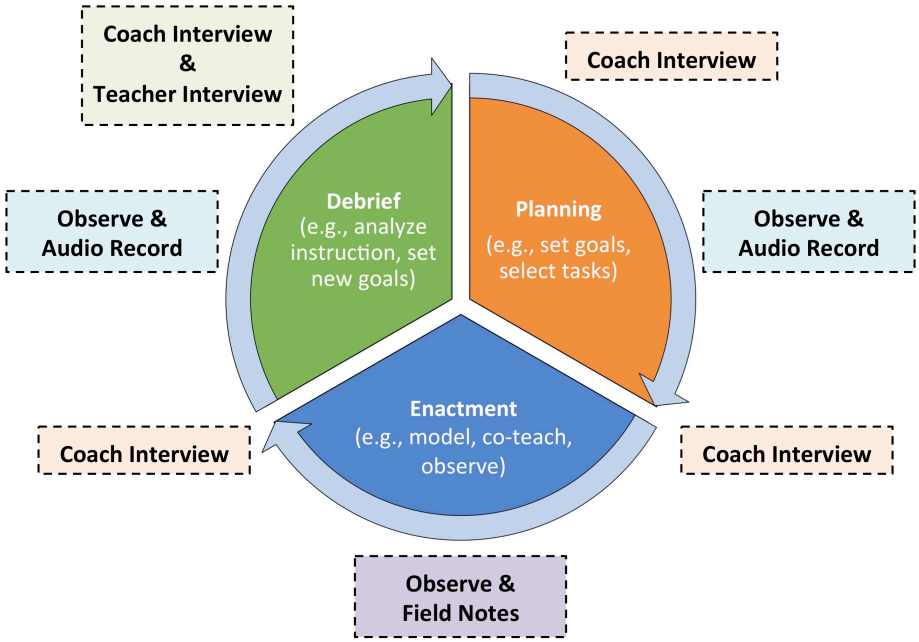
Research Methods

Data Collection

Over the course of the design study, we collected data to document the seven focal coaches' practices as they enacted coaching cycles with teachers. Three trained data collectors, the project coordinator, and I collected the data. The three trained data collectors were a former mathematics coach, a current doctoral student in mathematics education, and a former middle school administrator. All three trained data collectors had expertise in both ambitious mathematics instruction and in collecting evidence of instruction during lesson observations. We conducted an initial training session for the data collectors and the project coordinator in which we explained the purpose the project and our data collection process. I also accompanied each of the data collectors when they documented the three phases of their first coaching cycle in order to provide job-embedded support. In total, we documented 35 coaching cycles over the course of

the school year. Figure 2 (below) outlines the data collection process and highlights the data collected in each phase of a coaching cycle.

Figure 2: Data Collection Process



At the beginning of each cycle, data collectors conducted an interview to document how coaches had prepared for the planning phase. Using an audio-recorded, semi-structured interview protocol (see Appendix C for all interview protocols used in data collection), data collectors asked coaches to describe their plans for the upcoming planning conversation, as well as how those plans addressed the instructional improvement goals from either the goal setting process or the end of the prior cycle. Data collectors then observed and audio recorded the subsequent planning phase. Following the planning phase, data collectors conducted a second audio-recorded semi-structured interview with coaches. The goal of these interviews was to clarify coaches' interpretations of their planning conversations, as well as their goals and plans for the

upcoming classroom instruction phase. As part of these interviews, data collectors asked about key coaching decisions, such as whether coaches intended to model, co-teach, or observe and collect evidence, as well as coaches' rationales for those decisions.

Data collectors then observed the enacted lesson. Unfortunately, due to IRB concerns, we were unable to videotape or audio-record these lessons. However, data collectors used a structured observation protocol (see Appendix C) to record field notes detailing key aspects of the focal lesson. Our goal in collecting these data was to document the kinds of evidence required to determine whether the goals coaches identified for teachers' improvement of their instruction were productive. To this end, the data collection protocol focused on documenting students' learning opportunities and individual teachers' instructional practices during each phase of inquiry-oriented mathematics lessons. Specifically, the observation protocol oriented data collectors to collect the task(s) used in the lesson and document the level of rigor of the task(s); document how the teacher (or coach) launched the task; document whether the launch enabled all students begin working productively on the task(s); document the range of students' solution strategies by taking notes on students' strategies and taking pictures of students' work; and documenting whether the teacher (or coach) elicited students' reasoning and supported them to make connections between solution strategies during the whole class discussion.

After the lesson enactment phase, data collectors conducted a third semi-structured interview with coaches. The goal of these interviews was to understand coaches' assessment of teachers' progress toward previously agreed-upon instructional improvement goals and, if teachers had made progress, understand what coaches identified as new improvement goals, why coaches identified those goals, and how they identified those goals. Also, we aimed to understand what evidence, if any, the coaches analyzed to reach this determination, including

whether coaches analyzed evidence of students' learning (e.g., students' work) and of instruction (e.g., observation notes). If coaches saw evidence of improvement, we also sought to understand why it constituted progress. Finally, if coaches saw progress, we aimed to understand the new goal the coaches had identified for teachers' learning, the evidence they analyzed to identify those goals, their process in analyzing that evidence, their rationale for why the new goals were appropriate given teachers' current practices, and their rationale for why the new improvement goal would improve students' learning.

Next, data collectors observed and audio-recorded the debriefing phase of the coaching cycle, after which we then conducted a fourth semi-structured interview with coaches. Our goal for these interviews was to better understand coaches' thinking regarding a) the evidence discussed in the debrief; b) why coaches and teachers analyzed that evidence, if they did; c) whether and how coaches and teachers connected students' learning goals, students' thinking, and instruction in the debriefing conversation; and d) whether the analysis led to the negotiation of areas for future instructional improvement with the teacher.

Finally, data collectors also conducted semi-structured interviews with participating teachers after the debrief conversation. The goal of these interviews was to understand teachers' interpretations of what happened during the debrief phase, including their thinking related to a) the evidence analyzed during the debrief phase; b) their takeaways about instruction and/or students' learning based on the analysis, if it occurred; and c) whether the analysis led to the negotiation of areas for future improvement. Data collectors also asked teachers what they saw as the instructional improvement goals that would orient the next coaching cycle, whether they viewed those goals as worth pursuing, and how the coach and teacher decided on the improvement goals. Taken together, these coach and teacher interviews allowed me to assess

whether teachers' and coaches' understanding of the agreed upon improvement goals were compatible, whether the teachers saw the goals as worth pursuing, and whether the coaches saw the goals as productive.

Focal Data: Identifying Productive Instructional Improvement Goals. To determine how coaches identified productive instructional improvement goals (and thus answer my first research question), I analyzed: 1) interviews with coaches immediately following the classroom instruction phase of the coaching cycle and 2) field notes from observations of the focal lesson. The coach interviews enabled me to determine what coaches identified as improvement goals, as well as how coaches identified productive instructional improvement goals. This is because they provided information on a) whether the coach saw evidence that the teacher had made progress toward agreed-upon goals, b) if so, what the coach saw as a productive new goal for the teacher's learning, c) why the coach saw that as an appropriate goal, and d) how the coach identified the goal. The field notes of the focal lesson included both pictures of students' actual work and data collectors' inferences about students' solution strategies based on their conversations with students during the lesson, as well as documentation of the quality of successive phases of mathematics lessons. They therefore provided evidence that I could use to determine whether the goals identified by coaches were a) feasible to attain given teachers' current practices, and b) would, in all likelihood, support students' learning, if attained.

Focal Data: Negotiating Goals with Teachers. To determine how coaches negotiated agreed-upon goals with teachers, I analyzed: 1) audio-recordings of debrief conversations, 2) concluding interviews with coaches immediately following the debrief conversations, 3) concluding interviews with teachers immediately following the debrief conversations, and, when relevant, 4) field notes of the focal lesson. The audio-recordings of debrief conversations enabled

me to determine whether the coaches and teachers decided to continue working toward a previously agreed upon goal or negotiate a new improvement goal, as well as the process by which they made such determinations. The two concluding interviews with the coach and the teacher both included questions about their understanding of the improvement goals at the end of a cycle. Comparing these two interviews enabled me to determine whether coaches' and teachers' understandings of the agreed upon goals were compatible or whether the goals were only taken-as-shared. These interviews also included questions intended to elicit teachers' rationales about and justifications for the improvement goals, thereby providing evidence of whether teachers came to see particular goals as worth pursuing. Finally, the field notes enabled me to determine whether the negotiated goals were productive.

Data Analysis

I conducted separate analyses to answer my two research questions. My first analysis addressed my first research question (i.e., *How can mathematics coaches identify productive goals for teachers' improvement of their instructional practices?*). In this analysis, I determined whether the instructional improvement goals that coaches identified were productive or unproductive. I then compared cases in which coaches identified productive goals with those in which they identified unproductive goals. I did so in order to identify distinctions in coaches' goal identification processes. This, in turn, enabled me to specify a general process for identifying productive instructional improvement goals specific to individual teachers' practices. In my second analysis, I investigated my second research question (i.e., *How can coaches negotiate instructional improvement goals with teachers, such that coaches and teachers agree upon a productive goal?*) by closely examining the debrief conversations for cases in which

coaches identified productive instructional improvement goals. I focused on the cases in which coaches identified productive goals because, happenstance aside, identifying productive goals is a necessary prerequisite to negotiating productive goals successfully with teachers.

Analysis 1: Identifying Productive Instructional Improvement Goals. In my first analysis, I examined the 35 coaching cycles to determine whether and how coaches identified productive instructional improvement goals. I conducted this first analysis in four phases.

Phase 1: Assessing Adequacy of Data. In the first phase of this analysis, I identified and retained those coaching cycles for which I could determine whether the coach had identified a productive or unproductive instructional improvement goal. As noted in the data collection section, making this determination required two types of data: 1) an interview with the coach following the classroom instruction phase of the coaching cycle in which the coach was asked about a possible instructional improvement goal for the teacher and 2) field notes from the classroom instruction phase of the coaching cycle that were detailed enough to enable me to determine whether the coach's identified goal was productive. The data were adequate in 28 of 35 cycles.

Phase 2: Classifying Cases as Productive or Unproductive. Next, I analyzed each of the 28 retained cycles to determine whether the coach identified an instructional improvement goal that was a) feasible for the teacher to attain, and b) would improve students' learning, if attained, thereby satisfying my criteria for productive instructional improvement goals. To make this determination, I compared the goals that coaches identified in the 28 retained coaching cycles with the field notes from those cycles.

I used two approaches to determine whether an instructional improvement goal was feasible for the teacher. In 22 of the 28 retained cycles, coaches proposed goals that focused on

teachers making specific improvements in particular aspects of instruction. For these cases, I determined that goals were feasible if there was evidence in the field notes that the teacher was already enacting the aspect of instruction associated with the coach's proposed improvement goal, indicating the teacher could therefore improve the enactment of that aspect of instruction. For example, sequencing students' strategies during a whole class discussion would constitute a feasible goal for a specific teacher if there was evidence in the field notes that the teacher was already facilitating whole class discussions. I used a second approach for the remaining six cycles. In these cases, coaches proposed goals that involved teachers simply implementing a phase of a lesson, such as engaging students in a whole class discussion for the first time, or trying something new, such as counting to four following a question to increase students' think time. In all six cases, I classified the goal as feasible, because, by definition, it is always possible to try something for the first time.

I determined whether the improvement goal the coach identified would enhance students' learning, if attained, by comparing the coach's proposed improvement goals with my own assessment of the field notes from the focal lesson. This involved two steps. First, I analyzed the field notes from the classroom lesson to make my own determination about which aspects of instruction, if improved, would enhance students' learning opportunities. To do so, I reviewed the field notes by working backwards through the phases of inquiry-oriented lessons to identify when in the focal lesson students' learning opportunities *initially* broke down, if they did at all. This enabled me to determine whether the teacher's implementation of prior phases of the lesson hindered students' learning opportunities in subsequent phases of the lesson. In one case, for example, the field notes indicated that the teacher launched the task in ways that likely limited the range of students' strategies to a single method posed by the teacher. This resulted in the vast

majority of students solving the task using the teacher's strategy during work time. In the concluding discussion, the teacher called on a single student to share how he used the teacher's strategy correctly. Based on the field notes, I concluded that students' learning opportunities initially broke down during the launch of the task, as subsequent phases of the lesson depend on students solving tasks using a range of solution strategies. I therefore determined that students' learning opportunities would be enhanced if the launch was the phase of the lesson that the teacher worked to improve. I engaged in a similar process for all 28 cases and recorded the aspect of instruction on which I would choose to focus together with my rationale.

I then compared the results of my analysis with the aspect of instruction associated with the coach's improvement goal. If they matched, I took this as an indication that the coach's proposed goal would, in all likelihood, enhance students' learning, if attained. If my analysis of the field notes did not match the coach's proposed improvement goal, then I took it as a provisional indication that the coach's proposed improvement goal would not enhance students' learning, if attained. In conducting the aforementioned analysis, I identified 13 cases in which coaches' proposed improvement goals matched my own, and 15 cases in which they did not.

As a further step, I then conducted a second review of the coach interview and field notes for each of the these latter 15 cases in order to compare the coach's rationale for her proposed goal with the successive phases of the lesson, as documented by the field notes. My intent in doing so was to try and disprove my provisional assessment of the coach's goal. Reviewing the field notes confirmed my assessment in all but one case. In this case, the coach's proposed goal focused on the design and implementation of exit tickets, and thus the end of the lesson; whereas the goal I proposed focused on the whole class discussion. However, in reviewing the field notes alongside the coach's explanation for her proposed goal, I saw that designing and implementing

exit tickets would enable the teacher to better understand what students learned in the lesson, and thus better understand whether or not the whole class discussion contributed to students' learning. Exit tickets therefore had the potential to support the teacher in improving how she facilitated discussions. I therefore determined that the coach's proposed goal would enhance students' learning, if attained. In all, my analysis indicated that coaches identified productive instructional improvement goals that satisfied both criteria in 14 of the 28 coaching cycles.

Phase 3: Delineating Coaches' Approaches to Identifying Goals. In the third phase of the analysis, I characterized how the coaches identified instructional improvement goals in each of the 28 coaching cycles, regardless of whether the improvement goal the coach identified was productive or unproductive. To accomplish this, I analyzed the coach interviews conducted after the classroom instruction phase and delineated episodes in each transcribed interview in which the coach answered direct or implied questions about *how* they identified goals for teachers' improvement of their instructional practices. I then developed inductive codes to account for the different goal identification processes that the coaches described in these episodes (Corbin & Strauss, 2015). I approached this process inductively because there is limited research on how coaches identify productive instructional improvement goals, and thus no available coding scheme that was adequate for my purposes. However, when appropriate, I adopted language from Gibbons and Cobb's (2016) exploratory analysis of a single coach's goal-setting process.

Next, I refined my initial coding scheme to develop more general codes that described the *types* of processes or approaches by which coaches identified goals. This refined coding scheme included codes related to: a) whether coaches determined if the focal lesson constituted an improvement; b) whether coaches analyzed the lesson in detail and, if they did, how they analyzed the lesson; and c) how coaches determined goals for their partner teachers'

improvement, if they did not analyze the lesson in detail. I have included my refined coding scheme in Appendix B. I then conducted a second analysis of the coach interviews in which I used this refined coding scheme to categorize the identification processes the coaches described.

Phase 4: Comparing Unproductive and Productive Approaches to Goal Identification. In the fourth and final phase of the analysis, I compared the 14 cases in which coaches identified productive goals with the 14 cases in which they did not. I did so in order to identify distinctions in coaches' approaches to goal identification that explained why the coaches identified productive or unproductive goals. In making this comparison, I identified three approaches that distinguished between cases in which coaches identified productive goals and those in which they did not. These approaches included: 1) identifying goals based on the district's priorities or the teacher's priorities, as opposed to an analysis of the focal lesson; 2) identifying goals by analyzing only the teacher's actions in the focal lesson; and 3) identifying goals by considering the connection between the teacher's actions and students' learning opportunities in the focal lesson. To conclude this analysis, I wrote a series of memos that summarized my findings.

Analysis 2: Negotiating Productive Instructional Improvement Goals. In this analysis, I examined the 14 cycles in which coaches identified productive instructional improvement goals to determine whether and, if so, how they then negotiated instructional improvement goals productively with their focal teachers. This analysis involved three phases.

Phase 1: Comparing Coach and Teacher Instructional Improvement Goals. In the first phase of my analysis, I reviewed the coach and teacher interviews conducted at the end of each of the 14 relevant coaching cycles to determine whether the coach and teacher stated compatible instructional improvement goals in those interviews. I did so because stating compatible goals

indicates that the coach and teacher agreed upon an instructional improvement goal at the conclusion of the cycle. This is, by definition, a necessary outcome for successful negotiations.

I used the following criterion to determine whether coaches and teachers stated compatible goals: the coach and teacher referenced the same specific improvements to the same aspect of instruction. I engaged in a three-step process to determine whether cases satisfied this criterion. First, I analyzed the coach and teacher interviews separately, and recorded the stated goals using coaches' and teachers' own language. Second, I compared the coach's goal with the teacher's goal to determine whether they referenced the same aspect of instruction, such as the whole class discussion. Third, I determined whether they referenced the same improvement in the aspect of instruction, such as improving the sequencing of student solutions *during* whole class discussions.

In 12 of the 14 cycles, the coach and teacher were both explicit about the aspect of instruction and the proposed improvement. In one cycle, for example, the coach explained that the agreed upon instructional improvement goal involved implementing a new routine for encouraging students to share their reasoning with each other during small group work time. Similarly, the teacher explained that she intended to implement a new routine for "group work," with the goal of helping students talk more effectively with one another as they worked on the task. In this case, the phase and the specific improvement both clearly matched. In another of these 12 cycles, the coach explained that the improvement goal focused on the selection and sequencing of students' strategies during whole class discussions. In contrast, the teacher explained that she intended to implement a turn-and-talk routine in all phases of her upcoming lessons. In this instance, it was straightforward to determine that the phases of the lesson on which the coach and teacher focused did not match, and thus the specific aspects of instruction

that they identified also did not match. In the remaining two cycles, the coach was explicit about the lesson phase and specific aspect of instruction, but the teacher did not state an instructional improvement goal. One of these teachers listed off upcoming topics she intended to teach to students rather than stating an improvement goal, and the other said that she had forgotten the goal she had discussed previously with her coach. In all, I identified 10 cases in which the coach and teacher stated compatible instructional improvement goals.

Phase 2: Determining Whether Agreed Upon Goals Were Productive. I analyzed the 10 aforementioned cases to determine whether the agreed upon goals were, in fact, productive. I did so by first comparing the agreed upon goals with the productive goals identified by the coaches prior to the debrief phase of the coaching cycle. In nine of the 10 cases, the agreed upon goals were compatible with the productive goal the coach had previously identified and focused on the same phase of the lesson and similar improvements within that phase. In the remaining case, the coach and teacher agreed upon a different goal than the one identified by the coach prior to the debrief phase of the coaching cycle. For this case, I used the process for addressing my first research question. Using this process, I determined that the agreed upon goal was feasible and would improve students' learning, if attained, and was thus productive.

Phase 3: Comparing Productive and Unproductive Negotiations. In the third and final phase of my analysis, I examined each of the 14 debrief conversations in order to understand why some negotiations resulted in productive goals and others did not. To accomplish this, I first inductively coded for the topics that the coach and teacher discussed in each of the debrief conversations, as well as who initiated each topic. I considered a topic as starting when a coach or teacher brought up a new idea and ending when the coach or teacher initiated a shift in the conversation to focus on a new idea. For example, if a coach started the debrief conversation by

asking what did and did not go well in the lesson, this would mark the start of a particular topic of conversation. If the coach or teacher then discussed what students learned in the lesson, I considered this to be a shift to a new topic because the focus of their conversation changed.

After coding each debrief conversation, I then wrote a memo in which I listed the topics for the debrief conversation in the sequence that they occurred. This resulted in a set of 14 memos, each of which characterized the structure and focus of a debrief conversation. This enabled me to see when in each conversation the coaches and teachers explicitly discussed instructional improvement goals, as well as the topics leading up to and during those discussions.

I then compared the memos according to whether there was evidence that the coach supported the teacher in agreeing to and seeing a productive goal as worth pursuing. Similar to my first analysis, my goal in doing so was to clarify distinctions in the nature of coaches' and teachers' negotiations that explained why coaches were successful—or unsuccessful—in negotiating productive goals with teachers. Because little is known about negotiating goals with teachers, I used the constant comparative method to compare between the 14 cases (Corbin & Strauss, 2015). I concluded this phase of my analysis by summarizing my findings in a memo.

Findings

In this study, I conducted two related analyses in order to better understand how mathematics coaches can identify productive instructional improvement goals for individual teachers and how, on the basis of those identified goals, coaches can negotiate improvement goals productively with teachers. I report on my findings for each of the two analyses separately.

Analysis 1: How can mathematics coaches identify productive goals for teachers' improvement of their instructional practices?

As a reminder to readers, there was evidence that coaches identified productive goals in 14 of the 28 cases that I analyzed. The ways in which coaches identified instructional improvement goals fell into three broad categories: a) identify a goal based on either district priorities or the teacher's preferences, b) identify a goal based on an analysis of the teacher's instruction in the focal lesson, and c) identify a goal based on an analysis of the focal lesson in which coaches connected the teacher's instruction with students' learning. Table 1 (below) shows the case count for these three approaches, as organized by the resulting goal type.

Table 1: Case Count for Coaches' Approaches for Identifying Goal by Type of Goal

	Processes for Identifying Instructional Improvement Goal		
Type of Goal	Determine a goal based on district priorities or teacher preferences	Analyze the focal lesson by focusing on the teacher's instruction	Analyze the focal lesson by linking the teacher's instruction to students' learning
Productive (14 total cases)	0	0	14
Unproductive (14 total cases)	4	10	0

As Table 1 shows, all of the cases in which coaches identified productive goals involved the coaches analyzing individual teachers' instruction *in relation to* students' learning. In other words, the focal coach explicitly linked evidence of students' learning in the lesson with evidence of instruction, in order to consider the consequences of particular instructional decisions or teacher actions for students' learning. The evidence of student learning included, for example, the coach's notes on the range of student strategies in the lesson and whether that range

was such that the students and teacher could have a productive discussion. Evidence of instruction included the coach's notes on or recollections of the teachers' decisions and actions during in the lesson.

In contrast, none of the 14 cases in which coaches identified unproductive goals involved coaches engaging in this process. In ten of these cases, coaches identified goals by focusing solely on teacher's actions in isolation, without considering the consequences of those actions for students' learning. In the remaining four cases, coaches did not analyze the lesson in any detail, but instead identified goals based solely on either the district priorities or on the teacher's preferences. Significantly and unfortunately, this latter approach to goal identification is entirely consistent with two common approaches for identifying instructional improvement goals described in the current coaching literature, in that it foregrounded either school-wide, district-wide, or program-specific priorities (e.g., Haneda, Teemant, & Sherman, 2017; Killion, 2010; Teemant, Wink, & Tyra, 2011) or teachers' own assessments of their instructional practices (Sailors & Price, 2015; Knight, 2007, 2009). As I explain later, it is possible for coaches who take this approach to identify improvement productive goals, but the four cases I analyzed resulted in unproductive goals. In the following paragraphs, I describe representative examples of each approach. In doing so, I explain how the different approaches contributed to the type of goal the coach identified.

Identifying Goals Based on District Priority or the Teacher's Stated Preferences. In four of the 28 cases, coaches identified goals based on either their interpretations of district-wide priorities or teachers' stated preferences. As an illustration of this approach, one coach explained that she planned to help the teacher with whom she was working "do more [cognitively demanding] mathematics tasks" because that was "the district expectation." The coach did not

provide any further justification for the goal, nor did she explicate her process for coming to that conclusion, beyond citing the district expectation. In another case, a different coach explained that she intended to work on questioning with the teacher because the teacher had said she wanted to improve this aspect of her instruction in a previous meeting. Similar to the prior example, the coach did not provide further justification for the goal, beyond referencing the teacher's desire to focus on questioning.

In all four of the cases in which this approach was taken, coaches identified goals classified as unproductive. I therefore need to clarify that acceptance of a district's priorities could result in the identification of productive goal for a particular teacher. However, this fortuitous outcome is a consequence of happenstance, rather than a principled analysis of individual teachers' current practices. Similarly, it is possible for a teacher to identify productive goals for her own development. However, doing so requires the teacher to analyze her own practice, and thus act as her own coach. Although a small minority of teachers may have developed this capability, this is very much the exception rather than the rule. Of note, the third study of my dissertation provides evidence that coaches can support teachers to develop this capability through teachers' ongoing participation in one-on-one coaching cycles. In sum, this approach to goal identification has the potential to result in productive goals, but that potential rests on happenstance or a teacher's own capabilities, thereby mitigating a primary benefit of teachers working with coaches.

Identifying Goals Based on an Analysis of the Teacher's Current Instruction. In 10 of the 28 cases, coaches analyzed the lesson by focusing on specific aspects of the teacher's instruction during the lesson, without connecting instruction to students' learning. In my analysis, I identified a process that was generally representative of how coaches analyzed

teachers' current instruction in all 10 cases. Typically, the coaches first observed whether the focal lesson was an improvement over prior lessons. The coaches then described specific actions the teacher took in the lesson, without then describing the consequences of those actions for students' learning opportunities. Finally, the coach identified strengths or weaknesses in the teacher's current practice by implicitly or explicitly comparing what the teacher did in the lesson to the coach's own view of effective instruction. The coach's vision of effective instruction therefore served as the primary point of reference when identifying improvement goals in this approach.

In all ten cases, identifying goals in this way resulted in an unproductive goal. More specifically, the aforementioned process resulted in the coach identifying strengths and weaknesses in the lesson that were not directly relevant to improving students' learning opportunities. In one case, for example, the coach focused on the number and type of the questions the teacher asked in the lesson when identifying a goal for the teacher, without considering either whether asking those questions would support students' learning or why students may have struggled to learn in the lesson in the first place. In this case, the coach noted that the teacher had made progress in asking "a lot of questions," but that the majority of those questions were "lower-level questions." In making this observation, the coach first noted that the teacher had improved, and then implicitly compared the types of questions the teacher asked to her own understanding of effective questioning. Based on this comparison, the coach determined that questioning was a weakness in the lesson, and that working to improve the teacher's questioning would constitute a worthwhile improvement goal.

In this case, it was feasible for the teacher to address this weakness in her instruction, as she could certainly change the types of questions she asked at any point in the lesson. However,

there was evidence in the field notes that the teacher was consistently launching tasks in ways that did not support students in engaging meaningfully in the tasks. Therefore, working to address this weakness would not have improved students' learning, as only a few students in the class were consistently engaging in tasks in such a way that they would be able to respond to, and thus learn from, the teacher's improved questioning. In the other nine cases, there were similar discrepancies between my analysis of the focal lessons as documented in the field notes and the goals that the coaches identified.

Identifying Goals Based on an Analysis of the Teacher's Current Instruction and Students' Learning. In 14 cases, coaches analyzed the lesson by explicitly linking the teacher's instruction during the lesson to students' learning. This occurred in two ways. In the first approach, coaches described specific aspects of the teacher's instruction during the lesson, and then noted how those aspects either supported or inhibited students' learning, thereby determining whether they constituted strengths or weaknesses. In the second approach, coaches identified successes in supporting students' learning or missed opportunities to support their learning, and then connect those successes or missed opportunities to specific aspects of the teacher's instruction, in the process determining whether aspects of the teacher's instruction constituted strengths or weaknesses. Regardless of the approach, coaches concluded their analysis of the lesson by pointing out either a) specific instructional strengths in the lesson that they intended to encourage teachers to continue doing or b) specific instructional weaknesses that they intended to address with teachers. This process is consistent with prior research on identifying productive goals for individual teachers' improvement of their instructional practices (e.g., Gibbons & Cobb, 2016), in that it focuses on assessing teachers' current practices by linking students' learning and instruction. All fourteen cases in which coaches linked aspects of

teachers instruction to students' learning resulted in the identification of instructional improvement goals that were feasible for the teachers question to attain and would improve students' learning, if attained.

To illustrate this process, I focus on a representative case in which the coach determined that the teacher had a missed opportunity to support students' learning. The coach explained that the teacher had highlighted one of the two types of strategies that students had used to solve tasks and noted that the other strategy was more intuitive for students to understand and would thus have served as a productive starting point for the whole class discussion. On this basis, the coach identified the following weakness in the teacher's current practice: selecting and sequencing students' solution strategies. In making this determination, the coach noted that all students had engaged meaningfully in the work time and could probably have made sense of both strategies if the teacher had sequenced them effectively. There was evidence in the field notes from the lesson that corroborated this observation, indicating that improving this aspect of the teacher's facilitated instruction was both feasible and would have benefitted students' learning.

Summary. Coaches identified instructional improvement goals in three distinct ways. In four of the cases, the coaches identified goals based on their interpretations of the district's priorities or their teachers' priorities. In all four cases, I coded the resulting instructional improvement goals as unproductive. In ten of the cases, coaches identified goals based on their analysis of the teacher's instruction in focal lesson. In all of these cases, the analysis resulted in goals that were feasible for the teacher but unlikely to improve students' learning, if attained. Finally, in remaining 14 cases, coaches identified goals by analyzing aspects of the teacher's

instruction in relation to the students' learning in the focal lessons. Doing so resulted in goals that were both feasible and would improve students' learning, if attained.

Analysis 2: How can coaches negotiate instructional improvement goals with teachers, such that coaches and teachers agree upon a productive goal?

As a reminder to readers, I investigated this question by examining the 14 cases in which coaches had identified productive instructional improvement goals prior to negotiating goals with teachers. I focused on these 14 cases because, happenstance aside, identifying a productive goal is a necessary precursor to negotiating a productive goal successfully with an individual teacher. In this second analysis, I examined the 14 coach and teacher interviews conducted after each of debriefing conversations to determine whether the coaches and teachers stated compatible goals, and, if so, whether those goals were productive. I then analyzed the debrief conversations in order to identify the characteristics of conversations in which coaches negotiated productive goals successfully with teachers.

In all 14 cases, coaches and teachers negotiated instructional improvement goals after they had first discussed strengths and weaknesses for the lesson. In four of the 14 cases, coaches and teachers engaged in brief negotiations in which one person proposed a goal and the other immediately agreed to this goal. These four cases are not useful for answering my research question because I am interested in cases in which the coach and teacher initially disagree on an improvement goal. In one of these four cases, the teacher explicitly asked the coach to identify a goal for her improvement. In response to this request, the coach proposed the productive goal she had identified following the lesson observation. The teacher then agreed to the coach's goal. In their concluding interviews, the coach and teacher both said that they intended to work toward

the productive goal suggested by the coach, indicating the negotiation was productive. In the remaining three cases, coaches asked teachers to propose goals, and then agreed to teachers' proposed goals. In two of these three negotiations, teachers proposed productive goals, making further support unnecessary. In one of the three negotiations, the teacher proposed a goal that was feasible but unlikely to improve students' learning, if attained. In the debrief conversation, the coach agreed to this goal but then stated a different, productive goal in her interview.

In the remaining ten cases, the coaches and teachers initially disagreed on an improvement goal, and thus engaged in more protracted negotiations. In all ten cases, the coaches asked their teachers to propose goals for improving their teaching and, in each case, the goals the teachers proposed were incompatible with the goals the coaches had identified. Additionally, my analysis of the lesson field notes indicates that the teachers proposed goals that were unproductive because they did not focus on improving phases of lessons that would have significantly enhanced students' learning. In seven of the ten negotiations, the coaches supported the teachers to see alternate, productive goals as worth pursuing, as evidenced by the coaches and teachers stating compatible and productive goals in their concluding interviews. This indicated the negotiations were productive. In the remaining three cases, the coaches and teachers stated incompatible goals, indicating that the coaches negotiated goals unproductively.

In all ten cases, and regardless of the outcome, the coaches attempted to support their teachers in coming to see productive goals as worth pursuing by first eliciting the teachers' rationales for their unproductive goals. The coaches then reframed teachers' rationales to focus on the productive goals the coaches had identified. This process is consistent with an approach described in Haneda, Teemant, and Sherman (2017), in which they analyzed the practice of an accomplished coach. As an illustration, one of the ten teachers proposed an unproductive

improvement goal that focused on breaking cognitively demanding tasks down into smaller, less challenging problems. When the coach asked him to explain his rationale, he noted that he saw this as a way to improve students' confidence in mathematics, which he viewed as crucial to students' success. In response, the coach reframed the teacher's rationale by linking it to a more productive goal. Specifically, the coach asked, "And what do you think the discussion added [to students' confidence]?" In doing so, the coach acknowledged the teacher's desire to increase his students' confidence while also prompting the teacher to consider the discussion phase of lesson as worth improving.

In the seven productive negotiations, coaches accomplished two additional aims after eliciting and reframing teachers' thinking. First, the coaches supported teachers in understanding the goals they proposed by being explicit about the aspect of instruction they wanted the teacher to improve. In the illustration described immediately above, for instance, the coach was explicit about her focus on the discussion phase. The coaches were then clear about the improvements they intended teachers to make in those aspects of instruction, thereby further clarifying their proposed goals. Second, coaches supported teachers to see *why* specific improvements would benefit students' learning, thereby supporting teachers in seeing the coach's proposed goal as worth pursuing. In contrast, in the three unproductive cases, the coaches did not support their teachers in a) understanding their proposed goals or b) understanding why attaining coaches' proposed goals would enhance students' learning, and thus why those goals were worth pursuing. These two characteristics therefore distinguished productive negotiations from unproductive negotiations.

In the following paragraphs, I present two contrasting cases that are representative of the negotiation processes in all the productive and unproductive cases.

Case 1: Productive Negotiation. As background, this productive negotiation followed a lesson in which the teacher had used a cognitively demanding task. Based on my analysis of the lesson field notes, there was evidence that the teacher launched the task in a way that supported all students in being able to begin working on it productive. Further, the field notes from this lesson indicated that the students solved the task using a range of strategies, indicating there was opportunity for the teacher to facilitate a productive discussion. However, the teacher called on student volunteers to explain their different solutions, indicating that she did not have a readily apparent mathematical agenda for the discussion. I therefore determined it would be productive for this teacher to improve the ways in which she selected and sequenced the students' strategies in the discussion, as doing so was likely to enhance students' learning. The coach also identified this as a productive goal for the teacher's improvement.

In the debrief conversation following the lesson, the teacher proposed an initial goal that was unproductive. Specifically, the teacher explained that she wanted to support students in writing more complete responses during their independent work time. This goal was not compatible with the coach's identified goal, which focused on supporting the teacher in strategically selecting and sequencing students' strategies in the discussion. The goal was also not compatible with my analysis of the lesson field notes. Consistent with all ten focal negotiations, the coach then elicited the teacher's rationale for her proposed goal. When pressed to explain her rationale, the teacher said that she wanted to support her students in writing more complete written responses in order to help them construct better "mathematical arguments."

The coach then attempted to reframe the teacher's thinking in order to support the teacher to consider improvements in the discussion, rather than in how students wrote their responses to tasks during independent work time. In this case, the coach did so by asking the teacher, "How

do you foster that [mathematical argumentation] through whole class discussions?" In asking this question, the coach acknowledged the teacher's rationale for her initial goal while prompting the teacher to consider improvements to the whole class discussion. In making the lesson phase clear, the coach supported the teacher in understanding the broad focus of her proposed goal. In response to the coach's question, the teacher explained that hearing other students' arguments in whole class discussions might provide her students with models for the types of arguments she wanted to see in writing.

The coach and teacher then discussed how the teacher could facilitate whole class discussions more effectively. As they did so, the coach pressed the teacher to consider how and why she selected specific students to share in whole class discussion, thereby steering the conversation to the specific improvement she intended the teacher to make; namely, improving the ways in which the teacher selected and sequenced students' strategies in whole class discussions. This appeared to support the teacher in understanding the specific improvement at the center of the coach's proposed goal.

Crucially, the coach also supported the teacher in seeing how selecting and sequencing students' solution strategies in the whole class discussion could support students' learning, in addition to providing students with model mathematical arguments that they could imitate in their written work. For example, at one point in the negotiation, the teacher noted that she had "called on a few different people to talk" about their strategies in the focal lesson. The teacher explained that "hearing the same idea said several different ways" was beneficial for students, as it helped them hear different arguments. In response, the coach suggested an additional benefit to calling on multiple students, noting that selecting *particular* students to share might help listening students "make connections" between different strategies, and thus make progress in

their thinking. In making similar moves throughout the negotiation, the coach supported the teacher in seeing her attainment of the alternate goal as likely to enhance students' learning.

In the teacher interview that concluded the cycle, the teacher explained that she wanted to improve how she selected students to share their solution strategies in whole class discussions. Further, she explained that this would help students improve their mathematical arguments *and also* help students make connections between different strategies. Thus, the teacher agreed to the coach's alternate goal and also adopted the coach's rationale for that goal. This indicates that the coach had supported the teacher in coming to see her alternate, productive goal as worth pursuing.

As this case illustrates, negotiating goals productively with teachers involves eliciting and then reframing teachers' thinking. This approach acknowledges teachers' rationales for their proposed goals, thereby providing teachers with a voice in determining their goals, while also providing coaches with opportunities to introduce their productive instructional improvement goals. It also appears essential for coaches to support teachers in understanding the focus of coaches' proposed goals, as well as the specific improvements coaches intend teachers to make. As illustrated by this case, coaches can do so by explicitly naming the aspect of instruction on which she hoped to focus, and then pointing out the particular improvements the teacher might make in that aspect of instruction. Finally, it appears essential for coaches to then support teachers in seeing alternate goals as worth pursuing. Coaches can do so by pressing teachers to consider how attaining productive goals would benefit students' learning.

Case 2: Unproductive Negotiation. In this case, the negotiation followed a lesson in which the teacher demonstrated a procedure for calculating the volume of rectangular prisms and then asked students to solve a series of similar tasks using that procedure. In my analysis of the

lesson field notes, I determined that it would be productive to support this teacher in selecting cognitively demanding tasks. The coach noted a similar goal in her interview following the lesson observation, explaining that she wanted to support the teacher in consistently planning lessons around cognitively demanding tasks so that students would be able to discuss significant mathematical ideas during group work and whole class discussions, if they occurred.

The coach initiated the negotiation by asking the teacher to share what she wanted to work on next in her teaching. In response, the teacher noted that she was about to begin a review of measures of central tendency and she planned to remind students of the different procedures they could use to calculate mean, median, and mode. The teacher described several activities she intended to enact with her students that were all teacher-directed, and thus in line with the lesson the coach had observed.

The coach then attempted to reframe the teacher's thinking, thereby orienting the teacher to the coach's goal of designing lessons around cognitively demanding tasks. However, in contrast to the productive case described above, this coach did not explicitly name the aspect of instruction on which she hoped to focus. Instead, she asked the teacher to consider how she might become more of a "facilitator" in her lessons, "as opposed to a teacher" of the content. In her interview following the debrief, the coach indicated that her intent in asking this question was to point the teacher away from teacher-led lessons toward lessons organized around cognitively demanding mathematics tasks. However, as the coach was not explicit about her focus on task selection, it is unlikely that the teacher fully understood the coach's alternate goal.

The coach also did not support the teacher in seeing *why* becoming more of a facilitator would benefit students' learning, and thus why the change was worthwhile. Instead, the coach noted that this shift might help students "be responsible to each other as classmates." The teacher

then pushed back on the coach's proposal, noting that her upcoming lessons focused on review, and that her lesson plans were therefore sensible. This indicated the teacher did not see the coach's proposed goal as worth pursuing.

In response to the teacher's hesitancy, the coach adjusted her approach, asking the teacher if there were any opportunities in upcoming lessons for students to "do some shoulder partner work" as opposed to having the teacher "just up there." This second suggestion appeared to be another attempt to orient the teacher toward more student-centered lessons organized around cognitively demanding tasks. Again, the coach did not support the teacher in understanding her proposed goal, nor did she support her teacher in seeing why attaining the alternate goal would enhance students' learning. The teacher again pushed back, noting she was just "unsure where [her students] were going to be" in their thinking during the lessons. This indicated the teacher still did not see the coach's proposed goal as worthwhile.

From there, the negotiation devolved into a discussion of tips and tricks for boosting students' engagement in the teacher's "sometimes boring" lessons. In the interview that followed the debrief conversation, the teacher stated a goal focused on the tips and tricks she and her coach had discussed at the end of the negotiation. For her part, the coach stated a goal focused on supporting the teacher in selecting cognitively demanding tasks. This discrepancy indicated the coach was unsuccessful in supporting the teacher to see her alternate goal as worth pursuing.

In this unproductive case, the coach did not support the teacher in a) fully understanding her proposed goal and b) seeing that the attainment of the goal was likely to enhance students' learning, and thus as worth pursuing. These two limitations in the coach's negotiation were generally representative of the other three unproductive negotiations. In contrast, coaches were clear about the focus of their alternate goals in all seven cases in which they negotiated

productive goals successfully. Further, and as shown in the productive case described previously, these coaches all supported the teachers in seeing alternate goals as worthwhile. They did so by supporting their teachers in understanding that their attainment of their alternate goals would enhance students' learning. The contrasts between the two illustrative cases highlight that it is essential for coaches to accomplish these two aims.

Summary. Coaches engaged in protracted negotiations in ten of the 14 cases analyzed in this study. In these ten negotiations, the coaches asked their teachers to propose instructional improvement goals, and the teachers proposed unproductive goals. The coaches then attempted to support their teachers in seeing the coaches' productive goals as worth pursuing by eliciting teachers' rationales for their proposed goals, and then reframing teachers' rationales in order to propose productive goals. Coaches were successful in supporting teachers to see their productive goals as worth pursuing in seven of the ten negotiations. In these seven productive negotiations, coaches supported teachers in a) understanding their goals and b) understanding *why* attaining the coaches' goals would enhance students' learning. Coaches did not accomplish either of these aims in the three unproductive negotiations.

Discussion

In this study, I sought to clarify how mathematics coaches can identify productive goals for individual teachers' improvement of their instructional practices. I also sought to determine how, on the basis of their identified goals, coaches can negotiate goals successfully with teachers, such that coaches and teachers agree to productive instructional improvement goals. I conducted two related analyses to answer these two questions.

In the first analysis, I investigated how coaches can identify productive instructional improvement goals. I did so by examining 28 cases in which coaches identified instructional improvement goals as part of one-on-one coaching cycles. I found that coaches identified productive instructional improvement goals in 14 cycles, and did so based on an analysis of the focal lesson in which they linked the teacher's instruction with students' learning. There was evidence that coaches identified unproductive goals in the other 14 cases. In these 14 cases, coaches identified goals in two ways: a) based their interpretations of district priorities or the teacher's preferences and b) based on an analysis of the focal lesson in which they focused only on the teacher's instruction, and not on the connection between instruction and students' learning.

In the second analysis, I examined ten coaching cycles in which coaches identified productive goals and teachers initially proposed unproductive goals. I did so in order to understand how coaches can support teachers in coming to see alternate, productive goals as worth pursuing. I found that it was essential for coaches to support teachers in a) understanding coaches' productive goals and b) in coming to see the attainment of coaches' goals as likely to enhance students' learning. Doing so appeared to support teachers in coming to see coaches' productive goals as worth pursuing.

The findings of these two analyses contribute to research on coaching in several ways. First, my findings substantiate the process for identifying instructional improvement goals described in Gibbons and Cobb's (2016) exploratory analysis of an accomplished coaches' practice. In brief, both studies highlight the importance of coaches analyzing a lesson by considering the relationship between instruction and students' learning opportunities when identifying next steps in a teachers' development. At the same time, my analysis extends the

work of Gibbons and Cobb (2016) by clarifying that engaging in this type of analysis can result in coaches identifying *productive* instructional improvement goals that are a) feasible and b) likely to improve students' learning, if attained. This is an important contribution to the literature on high-quality coaching, as Gibbons and Cobb were unable to make this determination due to the data available to them.

My analysis also further clarifies how coaches can negotiate goals with teachers. I found that coaches who negotiated productive goals successfully with teachers first elicited the goals their teachers had in mind, and then reframed their teachers' rationales for those goals in order to support them in considering the productive goals the coaches had in mind. Additionally, I found it was essential for the coaches to support their teachers in understanding the coaches' proposed goals, as well as seeing how attaining the coaches' proposed goals would benefit students' learning. This appeared to support teachers in coming to see coaches' proposed goals as worth pursuing. Specifying these two characteristics of successful negotiations elaborates on and extends a process described in Haneda, Teemant, and Sherman (2017), and thus constitutes a significant contribution to the literature on coaching.

In addition to making research contributions, my findings also have pragmatic implications for efforts aimed at supporting coaches' learning. My findings indicate that mathematics coaches require expertise beyond that involved in being an accomplished teacher in order to identify and negotiate productive instructional improvement goals. Many coaches will therefore require support for their learning if they are to accomplish these two tasks successfully with teachers. In clarifying how coaches can identify productive instructional improvement goals and, on that basis, negotiate goals successful with teachers, I specify potential goals coaches' learning. These goals can inform the design of coach professional development. For example,

researchers and district leaders might partner to design professional development that focuses on supporting coaches to analyze lessons by connecting teachers' actions with students' learning opportunities, with the aim of supporting coaches to identify productive instructional improvement goals.

In conclusion, effective one-on-one coaching involves coaches identifying productive instructional improvement goals for individual teachers (Gibbons & Cobb, 2016; Haneda, Teemant, & Sherman, 2017; Olson & Barrett, 2004) that are both feasible for teachers to attain and likely to support students' learning, if attained. At the same time, it is essential that coaches to negotiate goals with teachers, as doing so ensures that teachers have a voice in determining their improvement goals (Robertson et al., in press; Haneda, Teemant, & Sherman, 2017). While these two aspects of coaching practice are essential to high-quality coaching, they are under-examined in the coaching literature. In this analysis, I identified a process by which coaches can identify productive instructional improvement goals, as well as a process by which coaches can negotiate goals productively. This contributes to our understanding of high-quality coaching, as well as what coaches need to know and be able to do to enact one-on-one coaching effectively. My findings therefore clarify potential goals for supporting coaches' learning.

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APPENDIX A

Coach PD Session Sequence

Session	Session Focus & Big Ideas	Tools/Takeaways
0	**Vision of High Quality One-on-One Coaching:** ● The goal of high quality coaching is to support teachers in better supporting students' attainment of rigorous math learning goals	Image of the goal-setting process and coaching cycle
1	**Beginning a One-on-One Coaching Partnership:** ● Coaches can frame coaching as improvement work by meeting with teachers to discuss their improvement goals.	Handout for recording teachers' practices and goals
2	**Identifying Potentially Productive Improvement Goals for Individual Teachers:** ● A key aspect of high quality one-on-one coaching involves supporting teachers in seeing how they can improve their teaching, and thus improve students' learning opportunities	Case study Student work tool
3	**Negotiating Potentially Productive Improvement Goals with Teachers:** ● Teachers need to see goals as sensible and worth pursuing if they are to engage in the challenging work of improving their teaching.	Case study Negotiating goals talking points
4	**Selecting classroom coaching activities to support teachers' improvement of their instructional practices** ● High quality coaching involves making principled decisions about the type of classroom coaching activities (e.g., observing and collecting evidence, co-teaching, modeling) that would best support teachers in improving their instructional practices.	Case study
5	**Recap Previous Learning and Examine Student Survey of Key Aspects of Mathematics Instruction** ● Students' perspectives on instruction can provide coaches and teachers with useful information that they can use to analyze instruction.	Student survey
6	**Engaging Teachers in Evidence-Based Debrief Conversations** ● Evidence-based debrief conversations provide coaches with an opportunity to support teachers in analyzing what students learned and why they learned it.	Case study
7	**Co-Planning with Individual Teachers** ● Co-planning involves supporting teachers in designing a lesson that has the potential to support students in making progress to identified learning goals and *also* supporting teachers in improving their instructional practices in the long-term.	Co-planning scenario / rehearsal
8	**System of Measures** ● Effective coaching is goal-directed, so coaches can select measures of different instructional practices based on their negotiated goals.	Reflection activity & Packet of measures

APPENDIX B

Coding Scheme:

Coaches' Approaches for Identifying Instructional Improvement Goals

Code	Description	Example(s)
Determine Progress to Previously Identified Goal	Coach references previous goal for teacher's improvement and then makes a judgment about the extent to which the teacher has achieved that goal	"I definitely saw progress. I definitely saw intentionality on behalf of [the teacher] in the types of questions that she was asking…" "I think [the lesson] went really well… At least 95 or more percent of the class was engaged in the [task] and talking. There were some really good mathematical discussions, and so I documented some of that [conversation]."
Analyze the Lesson: Teachers' actions that contributed to missed opportunities for students' learning	Coach describes what the teacher did *in connection to* missed opportunities to support students' learning OR Coach describes missed opportunities to support students' learning, and links those missed opportunities to a particular action or instructional decision	"Yeah. But I was disappointed with [how she facilitated] the true-false. Because there's so much opportunity there for them to talk. For the students to talk and the students to explain their thinking and why they thought that. And I think that might've led to more clarity when they were doing the task cards." "She did raise it, but then she didn't go very deep into the reasons why a lot of the students had a horizontal number line, when a vertical number line is the logical way to look at this picture… "
Analyze the Lesson: Teachers' actions that supported students' learning opportunities	Coach describes what the teacher did *in connection to* successes in supporting students' learning OR Coach describes successes in supporting students' learning teachers' learning, and links those successes to a particular action or instructional decision	"There were learning opportunities there that the whole class got because they had that discussion. I'm confident because he does a great job of moving around the room when they're working. I'm sure he had some of these conversations with kids one-on-one, but the fact that it was brought out whole class. Then when they were going over it

		other students were like helping and I think that's a crucial component that he needs to make sure he's has an all his lessons. But I also think it's important that he realizes you have to kind of plan for it. Like those [discussions], [he] didn't really plan. He had two [coaches] in there that were kind of like, 'Hey, do this.'"
Analyze the Lesson: Teachers' actions with no link to students' learning opportunities	Coach describes what the teacher did in the lesson, without linking those actions to students' learning. In other words, the coach focuses exclusively on teaching	"She did pretty well, actually for the questions that were more open-ended. Kids did receive the three to five seconds of wait time before she called on somebody… It's just that the frequency of those, but she asked a lot of questions, it's just the majority of them are lower-level questions."
Identify Phase of the Lesson to Work to Improve	Coach implicitly or explicitly references a particular phase of the lesson as the focus of subsequent improvement efforts	"If we can get the launch down and now we've got launches under control, and we got our questioning [during small group] and we're getting better with our questioning, okay now let's starting get that end piece. That whole class discussion." "I saw a lot of teacher talk, which is what I've seen in the past… With not a lot of wrap up and whole class discussion to bring things together. So, I was hoping the next goal would be a whole class discussion to bring things together."
Pose Potential Concrete Change in Instruction	Coach explicitly clarifies a concrete, observable change (or multiple potential changes) that the teacher might make to improve instruction.	"I wonder if any accountable talk stems would have helped in that beginning [discussion], to have students maybe ask when she was... [going over] the true-false questions. Like just have one student say, 'I

		agree with what you're saying because,' so they can reiterate what they're thinking is *and* what the right answer is." "…Having students doing a jigsaw puzzle, where you have a group that's doing it a certain way, switch and go with another person or even do it in partners or they get together and they can tell each other about their different ways… I want to try that and just see if the students that were [initially unwilling] to talk in front of everybody would be willing to talk."
No Analysis of the Lesson: Identify Goal Based on Teacher's Preference	Coach poses a goal based on teacher's stated preference—implicates teacher's own assessment of her instructional practices	"Yes, that's the teacher's goal. In the end, she wants to strengthen student discussion in her class, and then we just said that we should model strong questioning, the teacher. And so that's our focus first."
No Analysis of the Lesson: Identify Goal Based on District Priority	Coach poses a goal based on her interpretation of the district priorities, and not on her analysis of the focal lesson.	"That is the framework for the district. It aligns to our core actions. If they're doing the number talk, they're having discourse. If they're doing a task, they're having a discourse about math, and that's really what we want students to be doing."

APPENDIX C

Data Collection Protocols for Coach PD Design Study

1. Before Co-Planning Coach Interview (15-20 min.)

Goals and Materials

Goals:

- Understand the coach's goals for the co-planning conversation

Materials

- Interview protocol
- Audio recorder (2, one as a back-up)

Introduction / Consent

Before turning the audio recorder on:

1. Explain the purpose of the interview.
Thank you for taking the time to meet with me today. As you know, we are interested in understanding your efforts to support your teachers to improve their instruction. To help us get a sense of how this work is playing out, I am going to ask you a few questions about your upcoming co-planning conversation.

2. Walk through the consent process.
Before we begin the interview, I want to remind you that participating in this study is voluntary and your responses are completely confidential. At any point during the interview, if you would like me to turn off the recorder, just tell me to do so. Do you have any questions before we begin?

Turn the audio recorder on:
This is (district). *It is* (date) *at* (time). *This is* (interviewer's name) *and I am interviewing* (coach's first name) *at* (school name).

Co-Planning Talking Points

1. **Plan for the conversation:** Please walk me through your plans for the upcoming co-planning conversation.
    a. *Probe:* Why are you planning to… [insert what coach says]?
    b. *Probe:* In what ways do you expect [insert what coach says] will help the teacher improve?
2. **Goal for the conversation:** What are your goals for the teacher's learning in the co-planning conversation?
    a. *Probe:* How will you know if you accomplished those goals in the co-planning?
3. **Tools or the conversation:** What artifacts or tools (for example, student work, tasks, etc.) are you planning to use in the co-planning conversation?

Closing

1. Before we end, is there anything I haven't asked that you think would be relevant to talk about?

2. Co-Planning Observation

Goals and Materials
Goals: - Understand what the coach does during the co-planning conversation
Materials
- Observation Protocol - Audio recorder (2, one as a back-up)
Things to consider when taking notes
What are the key issues you want to ask about in the follow-up interview? 1. What happened in the co-planning (e.g., the structure, what they talked about, etc.) 2. What did the coach/teacher identify as the mathematical goals for students' learning, if they did at all? 3. What did the coach/teacher identify as the pedagogical improvement goals for the teachers' learning, if they did at all?

Notes:

[**REMEMBER:** COLLECT A COPY OF THE LESSON PLAN/RECORD OF CO-PLANNING CONVERSATION (e.g., ask to be cc'd on follow-up e-mail)]

3. After Co-Planning Coach Interview (15-20 min.)

Goals and Materials

Goals:

- Understand the coach's rationale/decisions in the co-planning conversation
- Understand what the coach hopes to do based on the co-planning.

Materials

- Interview protocol
- Audio recorder (2, one as a back-up)

Introduction / Consent

Before turning the audio recorder on:

1. Explain the purpose of the interview.
Thank you for taking the time to meet with me today. As you know, we are interested in understanding your efforts to support your teachers to improve their instruction. To help us get a sense of how this work is playing out, I am going to ask you a few questions about your upcoming co-planning conversation.

2. Walk through the consent process.
Before we begin the interview, I want to remind you that participating in this study is voluntary and your responses are completely confidential. At any point during the interview, if you would like me to turn off the recorder, just tell me to do so. Do you have any questions before we begin?

Turn the audio recorder on:

This is (district). *It is* (date) *at* (time). *This is* (interviewer's name) *and I am interviewing* (coach's first name) *at* (school name).

Co-Planning Talking Points

1. **Goals for teachers' learning:** Remind me, what were your goals for this teachers' learning?
    a. *Probe:* Why?
2. **What happened in the conversation:** Thinking back, to what extent did the co-plan support the teacher meet these goal?
3. **Connecting co-planning to the rest of the cycle:** What is your next step for working with this teacher? Why… ?
    a. **IF coach says work with teacher in the classroom:** How are you planning to work with the teacher in the classroom?
        i. What will you focus on in your [observation / co-teaching / modeling]? Why?
        ii. What data are you planning to collect during your in-classroom work?

Closing

1. Before we end, is there anything I haven't asked that you think would be relevant to talk about?

4. Coaching Observation Protocol

General notes:
- *Refer to the teacher using the confidentiality code throughout (e.g., D21_4Theresa).*
- *Embed pictures taken during the lesson in this document where possible (e.g., pictures of selected student work, public records created during the lesson, the task).*

Teacher name: **Grade level:**
Block / period: **Date of observation:**
Number of students present: **Observer name:**

Which practical measure(s) were administered (if any)?

Additional notes about class (e.g., honors class, etc.):

PART 1: TASK [REMEMBER: Collect the task(s)!]

Practical Measure Rating
[Insert the rigor of the task practical measure]

PART 2: IMPLEMENTATION OF THE TASK

Launch: ***How did the teacher introduce the task(s) to students?***
Notes: - *If the task has a scenario, describe how the teacher introduced the scenario (or not at all)* - *How did the teacher introduce the mathematics in the task(s)?*
Work Time: ***How did students work on the task (e.g., small groups, individually, back and forth between small groups and individually…)***
Notes: - *How long was each phase? What was the structure of the work time? Did students work in groups? Individually?*
Range of Student Solutions: ***How did students solve (or begin solving) the tasks(s)?***
Take pictures of students' work *Notes :* - *In general, what was the range of student solutions?*
Whole Class Discussion: ***How did students discuss their solutions with the whole class?***
Notes: - *Did the teacher choose solutions or take random volunteers?*

- *Which solutions did the teacher choose?*
- *What did the teacher do when students were explaining (e.g., help the kids explain, leave them to explain, follow-up on the explanation, connect the solutions to one another)?*
- *How many solutions did students share? How often did the teacher do the above (e.g., help the kids explain, leave them to explain, follow-up on the explanation, connect the solutions to one another)?*

Classroom Climate: ***How do students behave to one another and the teacher?***

Notes:

- *What appeared to be the norms for student-student interactions? Teacher-student interactions?*
- *Did the classroom feel safe?*

Additional notes:

5. Post In-Class Work Coach Interview (15-20 min.)

Goals and Materials

Goals:

- Understand the coach's interpretation of the lesson
- Understand what the coach plans to do based on those interpretations (and why).

Materials

- Interview protocol
- Audio recorder (2, one as a back-up)

Introduction / Consent

Before turning the audio recorder on:

1. Explain the purpose of the interview.
Thank you for taking the time to meet with me today. As you know, we are interested in understanding your efforts to support your teachers to improve their instruction. To help us get a sense of how this work is playing out, I am going to ask you a few questions about your upcoming co-planning conversation.

2. Walk through the consent process.
Before we begin the interview, I want to remind you that participating in this study is voluntary and your responses are completely confidential. At any point during the interview, if you would like me to turn off the recorder, just tell me to do so. Do you have any questions before we begin?

Turn the audio recorder on:
This is (district). *It is* (date) *at* (time). *This is* (interviewer's name) *and I am interviewing* (coach's first name) *at* (school name).

Analyzing the Lesson Talking Points

1. **Goals for the lesson observation:** What were you hoping to see in the classroom? Why?
2. **Overview of the lesson:** What did you see in the lesson?
    a. *Probe:* Why did that stand out to you?
    b. *Probe:* Did you pay special attention to anything in the lesson? Why?
3. **Analyzing the lesson:** Overall, why do you think the lesson went the way it did?
    a. *Probe:* What in the lesson makes you think that?
4. **Goals:** What are your goals for this teacher now, based off the lesson we just observed?
    a. *Probe/restating the question:* In what ways have your goals for this teacher changed after the observation, If they have at all?
5. **IF COACH USES ROOT CAUSES TOOL:** Why did you use the [root causes tool] in your analysis?
    a. *Probe:* Can you walk me through how you used the [root causes tools]?
    b. Generic Probe: In what ways did using the root causes tool impact your analysis of the lesson?

IF COACH/TEACHER ADMINISTERS PRACTICAL MEASURE: Talking Points

Hand out the data AFTER asking about initial analysis. Give the coach a moment to look at it.

1. **Reviewing the data:** [Say] I'd like you to think aloud how you are making sense of these data. Let's start

with item 1 and just talk aloud to me about your thinking.

2. **Looking across the data:** Now, thinking big picture, what trends do you notice across the questions? Does anything stand out to you?
    a. **Probe:** Which questions tell you that?
    b. **Press:** What do you think led to the students to answer that way?
3. **Goals:** After looking at this data, what are you planning to work on with your teacher? What are your goals or next steps for this teacher?
    a. **Probe:** How is this different than your initial goal, if it is at all?

Planning for the Debrief

6. **Connecting in-classroom to the rest of the cycle:** What are you planning to do next with this teacher?
    a. *Generic probe:* Why… ?
7. **IF coach says debrief with the teacher:** What are you planning to [do/discuss] in the debrief?
    a. *Generic probe:* Why?
    b. *Probe on goals:* What are your goals for the debrief? What are you hoping the teacher will get from the debrief?
    c. How does your plan help the teacher get there?
        i. *If coach talks about next steps:* Why do you see [insert next step(s)] as appropriate for this teacher?
    d. *Probe:* What data are you planning to discuss during the debrief?
    e. *Probe on successful conversation:* Thinking about your upcoming conversation, how would you know if it was successful?
        i. *Probe:* What might you look for as evidence of success?

Closing

1. Before we end, is there anything I haven't asked that you think would be relevant to talk about?

6. Coach-Teacher Debrief Conversation Observation Protocol

General notes: - *Use "[AN: ...]" to capture any analytic notes from the researcher.* - *Refer to the teacher using the confidentiality code throughout (e.g., D21_4Theresa).*

Teacher name: **Date of observation:**

[**REMEMBER:** COLLECT A COPY OF THE EVIDENCE IF POSSIBLE (e.g., students' work, practical measures data, coach notes, etc.)]

Debrief Notes
Evidence discussed - What evidence do the coach and teacher discuss (if any)? - How does the coach introduce this evidence?
Structure of the conversation: - How does the coach begin the conversation? - What activities occur during the coaching conversation? - How does the coach end the conversation?
Next steps/goals: - What do the coach and teacher decide as next steps/goals?
Coach-teacher engagement: - Who does most of the talking? - To what extent does the coach press the teacher to explain his or her reasoning?

7. Debrief Follow-Up Interview with Coach (20 min.)

Goals and Materials
Goals: - Understand the coach's rationale/decisions in the debrief conversation
Materials
- Interview protocol - Audio recorder (2, one as a back-up)

Introduction / Consent
Turn the audio recorder on: *This is* (district). *It is* (date) *at* (time). *This is* (interviewer's name) *and I am interviewing* (coach's first name) *at* (school name).
Debrief Talking Points

1. **Goal for the conversation:** What did you hope to accomplish in the conversation? Why?
    a. *Probe:* Did the conversation go as expected? Why or why not?
    b. *Probe:* Did you accomplish your goals in the conversation? Why or why not?

2. **What happened in the conversation:** I noticed that you [insert notes from observation]...
    a. *Probe:* Why did you decide to do that at the time?
    b. *Probe:* What were you hoping to accomplish by… ?

3. **IF COACH USED DATA/PRACTICAL MEASURE(S):** Why did you decide to use the [data/practical measure data] in the way you did?
    a. *Probe:* What were you hoping would happen as a result of using the data representations in this way?
    b. *Probe:* How would you use similar data in a coaching conversation again?
4. **IF COACH USED DEBRIEFING TALKING POINTS:** Why did you decide to use the talking points document?
    a. *Probe:* To what extent did the talking points help you in your conversation?
    b. *Probe:* In what ways did they help?

5. **Changes to Goals:** Having seen the lesson and having talked with the teacher, have your changed in any way? If so, in what ways?
    a. *IF goals shifted:* What contributed to these changes?
    b. *IF goals shifted (alternative):* Why?

6. **Outcomes of the conversation:** What do you think the teacher sees as a next step for his/her teaching based on the coaching conversation?
    a. *Probe:* What in the conversation led you to think that?
    b. *Probe:* Is there anything you hoped the teacher would improve as a result of the conversation?

7. **Moving forward:** What are you planning to do next with this teacher? Why… ?
    - **a.** IF THEY SAY ANOTHER CYCLE: What will you focus on in your next cycle?
        - *i.* *Probe:* Why do you plan to focus on that?

Closing

1. Before we end, is there anything I haven't asked that you think would be relevant to talk about?

8. Debrief Follow-Up Interview with Teacher (20 min.)

Goals and Materials
Goals: - Understand the teacher's experience in the debrief and whether the teacher and coach ended up interpreting the next steps/goals the same way
Materials
- Interview protocol - Audio recorder (2, one as a back-up)

Introduction / Consent
Turn the audio recorder on: *This is* (district). *It is* (date) *at* (time). *This is* (interviewer's name) *and I am interviewing* (coach's first name) *at* (school name).
Debrief Talking Points
1. **Goals before conversation:** Before this cycle, did you have a goal for your own improvement? a. If so, what was it? How did you determine this goal? 2. **What happened in the conversation:** I noticed that you [insert notes from observation]... Why did you decide to do that at the time? **3. IF COACH USED DATA/PRACTICAL MEASURE(S):** In what ways did looking at [insert data] help you make sense of the lesson, if it did at all? **a.** *Probe:* How would you use similar data again in the future? **4. Goals after conversation:** After the conversation, what are your next steps/goals for improvement? *a. Probe:* How did you and your coach decide on these next steps/goals? What contributed to these next steps/goals? 5. **Goals to action:** What are you planning to do next based on this conversation? a. *Generic probe:* Why… ? *b. Generic probe:* When… ?
Closing
1. Before we end, is there anything I haven't asked that you think would be relevant to talk about?

CHAPTER IV

USING PRACTICAL MEASURES IN ONE-ON-ONE COACHING

Introduction

Currently, states across the country are implementing new standards that outline more rigorous goals for students' learning (e.g., Peterson Barrows, & Gift, 2016; Stage, Asturias, Cheuk, Daro, Hampton, 2013). In mathematics, these goals center on students' development of conceptual understanding, procedural fluency, and mathematical practices (e.g., constructing mathematical arguments, critiquing the reasoning of others). The findings of a number of studies link the attainment of these goals with teachers' development of *ambitious instructional practices* (e.g., Kazemi, Franke, & Lampert, 2009; Lampert, Beasley, Ghousseini, Kazemi, & Franke, 2010; Lampert & Graziani, 2009). These practices include, for example, selecting cognitively demanding mathematics tasks (Stein, Grover, & Henningsen, 1996; Stein & Lane, 1996), introducing tasks so that all students can begin working productively without lowering the cognitive demand (Jackson, Shahan, Gibbons, & Cobb, 2012), and facilitating mathematics discussions in which teachers press and support students to explain their reasoning and make connections between different solution strategies (Kazemi & Stipek, 2001; Stein, Engle, Smith, & Hughes, 2008).

For many mathematics teachers, these instructional practices differ greatly from their current forms of instruction. Mathematics teachers' development of these practices therefore requires that they significantly reorganize aspects of their instructional practices (e.g., Wood, Cobb, & Yackel, 1991). This professional learning is challenging work that requires sustained,

job-embedded support (Cohen & Hill, 2001; Darling-Hammond & Richardson, 2009). Prior research has identified several forms of support for teachers' learning that, if implemented effectively, can enable teachers to improve their instructional practices. These include coherently sequenced professional development (PD) sessions (e.g., Garet et al., 2001; Desimone, 2009), teacher collaborative time (TCT) led by an accomplished facilitator (e.g., Horn, 2010; Horn & Kane, 2015), and one-on-one content-focused coaching (e.g., Kraft, Blazar, & Hogan, 2018; Neufeld & Roper, 2003; West & Staub, 2003).

This study focuses on one of these potentially productive forms of support: one-on-one content-focused coaching. In one-on-one coaching, a coach and a teacher work together to improve aspects of a teacher's instructional practice (Coburn & Russell, 2008; Hull, Balka, & Miles, 2009; Mudzimiri, Burroughs, Luebeck, Sutton, & Yopp, 2014). Research examining one-on-one content-focused coaching is relatively new, and the field has made significant progress in recent years. Scholars have identified the potentially productive one-on-one coaching activities that can support teachers' learning when enacted effectively, such as co-teaching, modeling, and one-on-one coaching cycles (Gibbons & Cobb, 2017). The field has also begun to clarify what coaches need to know and be able to do to enact these activities effectively with teachers (e.g., Haneda, Teemant, & Sherman, 2017; Hindman & Wasik, 2012; Russell et al., 2016; Russell et al., 2017). Taken together, these findings take steps to clarify what is involved in the kind of high-quality one-on-one coaching that evidence indicates can support mathematics teachers' learning.

At the same time, studies of larger-scale coaching initiatives reveal significant variation in the quality of coaching that teachers receive (e.g., Atteberry & Bryk, 2011; Kane & Rosenquist, 2018), with many teachers receiving limited—if any—opportunities to engage in the

kind of high-quality coaching that can support their development of ambitious instructional practices (Cobb, Jackson, Henrick, Smith, & the MIST team, 2018). There are a number of potential reasons for this. Studies have found, for example, that the size of a coach's caseload (Atteberry & Bryk, 2011), state and district policies (Coburn & Russell, 2008; Deussen, Coskie, Robinson, Autio, 2007), and coaches' relationships with their principals can influence the nature and quality of their work with teachers (e.g., Gibbons, Garrison, & Cobb, 2011; Grant & Davenport, 2009; Matsumura, Sartoris, Bickel, & Garnier, 2009). Evidence also indicates that high-quality coaching is, simply put, challenging work that requires coaching-specific expertise beyond that involved in being an accomplished teacher (e.g., Bengo, 2016; Gallucci, Van Lare, Yoon, & Boatright, 2010; Gibbons & Cobb, 2016). This type of expertise is often rare in schools and districts (Cobb et al., 2018). Supporting coaches to be more effective in their practice is therefore a pressing problem.

In this context, teachers stand to benefit from tools that can enable coaches to be more effective in their coaching. With this in mind, this study investigated the possibility that mathematics coaches' use of a specific tool—a practical measure of instruction—can enable them to be more effective in supporting mathematics teachers' learning. *Practical measures* of instruction are intended to provide educators (e.g., teachers, coaches, district leaders) with rapid feedback that enables them to determine whether changes in instruction are improvements (for more on practical measures, see Bryk, Gomez, Grunow, LeMahieu, 2015; Yeager et al., 2013). Practical measures are also intended to be quick and relatively easy to administer. This ensures the measures fit with educators' current practices and routines, and thus do not disrupt their work, thereby enabling their ongoing use. Given these intended uses, practical measures of instruction differ from other the types of measures used in education, including "the summary

evidence routinely used for accountability purposes" and research measures "used to advance original scientific theories" (Yeager et al., 2013, p. 7).

In one-on-one coaching, coaches and teachers can use data from practical measures of instruction to determine whether the particular changes teachers are making in their instruction are improvements. In this study, I investigated whether and, if so, how coaches' use of practical measures of instruction can enable them to improve the quality of their coaching with teachers in other ways, beyond just enabling coaches and teachers to determine whether changes in instruction are improvements. Thus far, only a small number of empirical studies have examined the use of practical measures in educational improvement initiatives (e.g., Krumm et al., 2016; Hannan, Russell, Takahashi, & Park, 2015; Silva & White, 2017), and none of these studies have investigated whether and how coaches' use of practical measures can enable them to improve their one-on-one coaching. This study therefore contributes to our understanding of practical measures, as well as our understanding of how coaches can use practical measures as tools to enact high-quality one-on-one coaching effectively with teachers.

While this study focused on coaches' use of practical measures in one-on-one coaching, my findings also have implications for PD and TCT. As I describe later, this is because high-quality coaching, PD, and TCT all involve accounting for students' learning with regard to instruction—and discussing data from practical measures of instruction may prove beneficial in this type of analysis. By accounting for students' learning with regard to instruction, I mean determining what students learned in the course of lesson, and then analyzing instruction to explain that learning. This process mirrors that of effective formative assessment practices (e.g., Wiliam & Black, 1996), and involves linking data on students' thinking (e.g., students' written work) with data on instruction (e.g., written field notes), all in relation to the student learning

goals for the lesson (e.g., Matsumura, Correnti, Walsh, Bickel & Zook-Howell, 2019). Because these three types of support each involve variations on this process, my findings have significance for research on the use of practical measures of instruction in supports for teachers' learning, beyond just coaching.

In what follows, I first describe the practical measure of instruction used by the coaches and teachers in this study. Next, I describe high-quality one-on-one coaching in greater detail, focusing on the coaching cycle as a form of one-on-one coaching for which there is evidence that it can support teachers in improving their instruction. I then outline how coaches and teachers can integrate practical measures of instruction in one-on-one coaching cycles, in the process developing two specific conjectures regarding the additional contributions of practical measures of instruction. Following this discussion, I describe the research context and methods involved in this particular analysis. I then share my findings, followed by a discussion of those findings.

Focal Practical Measure: Measure of Whole Class Mathematics Discussions

In this study, I investigated coaches' use of a particular practical measure of instruction. The measure focuses on the quality of whole class mathematics discussions and takes the form of a short student survey documenting students' perspectives on what happened during the whole-class discussion(s) for a particular mathematics lesson. The student survey includes seven items and is designed to take 1-2 minutes for students to complete, making it quick to administer. It is important to note that the design of the whole class discussion measure is based on an empirically grounded consensus regarding the forms of instruction that can support students in attaining rigorous mathematical learning goals (e.g., Lampert, Beasley, Ghousseini, Kazemi, &

Franke, 2010). Taken together, these forms of instruction constitute what scholars have termed an *ambitious vision of high-quality mathematics instruction* (Munter, 2014; Cobb et al., 2018).

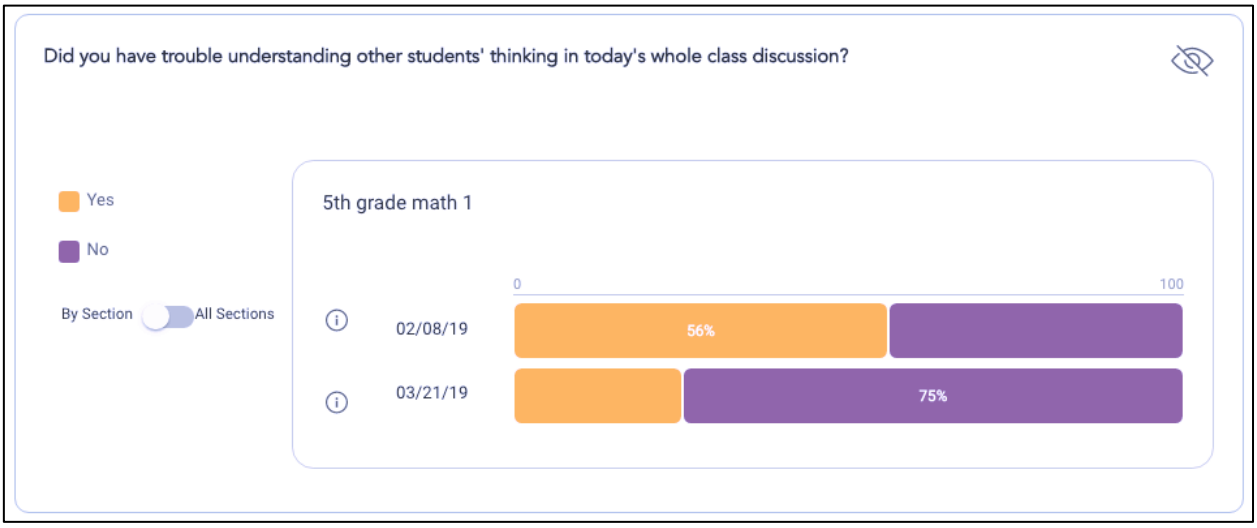
Building from research on effective mathematics instruction, each item focuses on an aspect of whole-class mathematics discussions that research indicates is associated with students' attainment of rigorous mathematical learning goals. These aspects include: 1) the cognitive demand of mathematics tasks as implemented (e.g., Stein, Grover, & Henningsen, 1996); 2) what students are accountable for in whole-class mathematics discussions (e.g., Cazden, 2001); 3) opportunities for students to listen to, reason about, and make sense of other students' ideas in whole-class discussions (e.g., Thompson et al. 1994); 4) the establishment of a classroom culture in which students feel safe and are encouraged to share their ideas (e.g., Horn 2012; Kazemi & Stipek, 2001); and 5) centering students' thinking in discussions (e.g., Cobb, Yackel, & Wood, 1989). Appendix A outlines the items and their justifications. See Jackson, Henrick, Cobb, Kochmanski, & Nieman (2016) for more on the design and development of the survey.

As an example of the types of items on the survey, item 4 of the survey reads, "Did you have trouble understanding other students' thinking in today's whole class discussion?" Students can respond to this item by selecting either "yes" or "no." As explained further in the appendix, this item is intended to provide educators with feedback on whether students had opportunities to listen to, reason about, and make sense of others' ideas in the whole class discussion(s) for a lesson. In particular, this item is intended to provide information on whether students had trouble making sense of other students' ideas in the discussion.

Teachers and coaches are intended to look at the aggregate of student responses to each item for a particular lesson. To this end, researchers designed a corresponding data dashboard that teachers and coaches can use to view students' responses to the survey in the aggregate (for

more, see EdSight.io). The data dashboard displays student responses using stacked bar charts that indicate the percentage of students who responded to each of the response options for the items in a class period. Figure 1 (below) illustrates one kind of representation featured in the EdSight dashboard by showing students' responses to one item. Teachers and coaches can use the data dashboard to compare student responses to the survey across lessons, thereby enabling them to determine whether student responses to particular survey items changed over time.

Figure 1: Example Data Representation from EdSight Dashboard



It is important to note that most teachers will require support in identifying specific changes that they might make to address weaknesses in their instruction, as indicated by the data. This is because engaging in this kind of analysis involves identifying strengths and weaknesses in teachers' current practice, and then determining how to act based on those strengths and weaknesses. Expecting teachers to engage in this process without support runs counter to a long history of research on teachers' learning that indicates teachers require sustained support to improve their instructional practices (e.g., Cohen & Hill, 2001; Darling-Hammond &

Richardson, 2009). It is therefore essential that teachers analyze data from the discussion measure in supports for their learning, such as one-on-one coaching.

Focal Support for Teachers' Learning: One-on-One Coaching Cycles

The goal of this study was to investigate whether and, if so, how coaches' use of the practical measure of instruction in one-on-one coaching can enable them to be more effective in supporting individual teachers' learning. To investigate this possibility, I examined coaches' use of the aforementioned whole class discussion measure in one-on-one coaching cycles. I focused on coaching cycles because there is mounting evidence that engaging mathematics teachers in one-on-one coaching cycles can support them in improving their instructional practices, and thus improve students' learning, if they are enacted well (Russell et al., 2016; Russell et al., 2019).

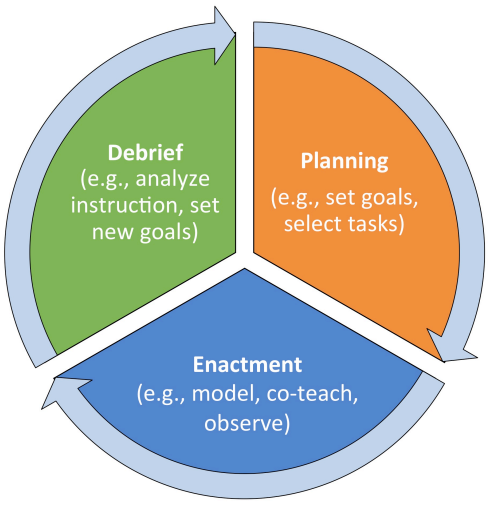
High-Quality Enactments of One-on-One Coaching Cycles

As they are typically described in the literature (e.g., West & Staub, 2003), one-on-one coaching cycles consist of three phases: 1) a lesson planning phase, 2) a lesson enactment phase, and 3) a lesson debrief phase (see Figure 2, below). In a high-quality enactment of the lesson planning phase, individual coaches and teachers plan an upcoming lesson by clarifying and reiterating goals for students' learning *and* for the teacher's improvement of her instructional practices. Coaches and teachers then select instructional tasks consistent with the agreed-upon student learning goals; work together to design a lesson around those tasks; and plan together for the teachers' enactment of the lesson (Russell et al., 2016; Russell et al., 2017). Russell et al.'s (2016) findings also indicate that it is essential for coaches to engage teachers in "deep and specific discussions" that link mathematical learning goals, students' thinking, and instruction as

they engage in this planning process (p. 9). When facilitated well, these kinds of discussions can involve teachers and coaches specifying particular changes in instruction for the subsequent lesson, with the aim of better supporting students in attaining particular learning goals. In a high-quality enactment of this phase, these changes are also based on previously identified goals for the teacher's improvement of her instructional practices.

In the subsequent lesson enactment phase, teachers then implement the planned lesson with students. As it is typically described in the literature, a high-quality enactment of this phase involves individual coaches observing teachers' implementation of the lesson and collecting data to provide teachers with feedback (e.g., Russell et al., 2017; Teemant, Wink, & Tyra, 2011). Typically, this involves coaches collecting examples of students' written work and writing field notes to document aspects of the teacher's instruction (e.g., Haneda, Teemant, & Sherman, 2017; Olson & Barrett, 2004). As explained below, collecting these data on students' reasoning and on teachers' instruction is critical, as these data are central to high-quality enactments of the debrief phase. Recent elaborations of the coaching cycle also indicate that coaches may choose to co-teach or model instruction during this phase of a cycle (e.g., Campbell & Malkus, 2014).

Figure 2: One-on-One Coaching Cycle



In the concluding debrief phase, individual coaches and teachers analyze the focal lesson. In line with effective formative assessment practices (e.g., Wiliam & Black, 1996), the primary goal of this analysis is to account for students' learning with regard to instruction. Put another way, the primary goal of this analysis is to support teachers in accounting for students' learning with regard to instruction by a) determining what students learned in the course of lesson and b) analyzing instruction in order to explain that learning. Facilitating debrief conversations effectively therefore involves coaches supporting teachers in linking data on students' thinking (e.g., students' written work) with data on instruction (e.g., written field notes), all in relation to student learning goals for the lesson (e.g., Matsumura, Correnti, Walsh, Bickel & Zook-Howell, 2019). This type of analysis necessarily results in the identification of strengths and weaknesses of the lesson, thereby enabling coaches and teachers to identify areas for individual teachers' further improvement in an evidence-based manner.

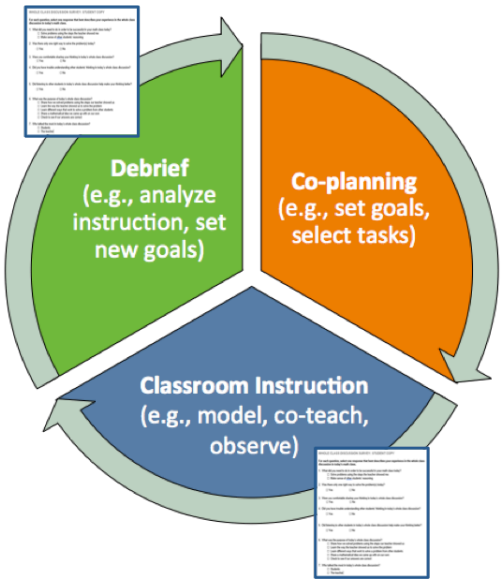
It is therefore critical that coaches collect data on students' reasoning and data on instruction in coaching cycles, as the data form the basis for the kind of analysis central to high-quality debrief conversations. Students' work can serve as a readily available source of data on students' thinking when more accomplished educators, such as coaches, support teachers in making sense of that work in relation to student learning goals (e.g., Kazemi & Franke, 2003; Kazemi & Hubbard, 2008). With regard to data on instruction, coaches and teachers typically rely on the coach's written field notes, if the coach takes them (e.g., Olson & Barrett, 2004). When available and relevant, coaches and teachers might also administer practical measures of instruction, such as the whole class discussion measure, in order to collect additional data on instruction. By definition, the whole class discussion measure provides an additional perspective on aspects of instruction linked to students' learning—the students' perspective. Because of this,

data from the discussion measure might augment the types of data on instruction coaches typically collect, and thus enable coaches and teachers to develop a clearer picture of instruction. With this point in mind, I now describe how coaches and teachers might use the practical measure of instruction in one-on-one coaching cycles.

Using the Practical Measure in One-on-One Coaching Cycles

Using the aforementioned whole class discussion measure in one-on-one coaching cycles involves two steps. First, coaches and teachers administer the measure during the lesson enactment phase of the coaching cycle. Second, coaches and teachers analyze the resulting data—along with more typical forms of data—in the debrief phase of the coaching cycle. Figure 2 (below) illustrates this process.

Figure 3: Embedding Practical Measures of Instruction in One-on-One Coaching Cycles



When integrated into coaching cycles, data from the whole class discussion measure can enable coaches and teachers to determine whether changes in instruction are improvements. For

example, a coach might work with a teacher to improve her facilitation of whole-class discussions, with the goal of supporting listening students in making better sense of the ideas shared during the discussion. In the planning phase of the cycle, the coach and teacher might plan to adjust the ways in which the teacher presses students to elaborate on their explanations in whole class discussions, in order to support students in clarifying their explanations for listening students. The coach and teacher might then identify a particular item on the whole class discussion measure that aligns with their improvement goal—in this case, perhaps item 4 (i.e., "Did you have trouble understanding other students' thinking in today's whole class discussion?"). In the lesson enactment phase, the coach and teacher might then administer the whole class discussion measure. In the subsequent debrief phase, the coach and teacher might analyze students' responses to the focal item along with other data (e.g., students' work, coach notes) to determine whether the teacher had made the planned change in instruction, and whether that change resulted in an improvement. In this example, the practical measure data could aid the coach and teacher in making this type of determination by providing them with data related to the planned instructional changes that they could track over time.

While practical measures are designed to enable users to determine whether changes in practice are improvements, the primary goal of this study was to investigate additional contributions of practical measures in one-on-one coaching. Specifically, I investigated the possibility that coaches' use of the whole class discussion measure in coaching cycles can enable them to improve their work with teachers, beyond just determining whether changes in instruction are improvements. More specifically, this study investigated the conjecture that discussing practical measure data with teachers in the debrief phase of coaching cycles can enable coaches to facilitate higher quality debrief conversations than would otherwise be the

case. If this conjecture is substantiated, then it indicates that integrating practical measures of instruction in one-on-one coaching cycles can enable coaches to be more effective in supporting teachers' learning. In what follows, I outline two ways in which coaches' use of the practical measure data might enable them to enhance the quality of debrief conversations with teachers, beyond just determining whether changes in instruction are improvement.

Conjecture 1: Account for Students' Learning with Regard to Instruction More Effectively

Recall that high-quality debrief conversations involve accounting for students' learning with regard to instruction. The extent to which coaches and teachers can conduct this kind of analysis depends, in part, on the types of data available to them. As outlined above, coaches and teachers typically use students' written work as data on students' reasoning, and coaches' field notes. By definition, the whole class discussion measure provides coaches and teachers with students' perspectives on aspects of instruction that are associated with their learning. It is possible that analyzing students' perspectives on the lesson might enable coaches and teachers to focus on aspects of instruction that have been linked to student learning and that would otherwise have been invisible to them. This, in turn, might enable coaches and teachers to explain *why* students learned or did not learn as expected in ways that, in all likelihood, would not have come up without the data. If this is the case, then the use of the practical measures data in the debrief phase might enable coaches and teachers to better account for students' learning with respect to instruction, and thus improve their debrief conversations.

Conjecture 2: Identify Areas for Instructional Improvement

This study also investigates a second conjecture regarding the use of practical measures in one-on-one coaching cycles: that the addition of data from practical measures of instruction might enable coaches and teachers to identify productive areas for instructional improvement, and thus improvement goals, that a) would not have come up without the data and b) are likely to improve students' learning, if attained. This conjecture is based on the idea that accounting for students' learning with regard to instruction necessarily results in the identification of instructional strengths and weaknesses that relate to students' learning, and thus potential areas for improvement. If the first conjecture proved viable, and analyzing the practical measure data can enable coaches and teachers to focus on aspects of instruction that they would not have otherwise, then it follows that the addition of the practical measure data might also aid coaches and teachers in identifying productive areas for improvement.

Research Questions

The goal of this study is to understand whether and how coaches' use of practical measures of instruction can enable them to be more effective in supporting teachers' learning than they would be otherwise. In this study, I investigated this possibility by looking closely at mathematics coaches' use of the aforementioned whole class discussion measure in the debrief phase of one-on-one coaching cycles. The following questions guided this analysis:

1. *Can coaches' use of the practical measure data in one-on-one coaching cycles improve the quality of their debrief conversations with teachers? If so, how?*
2. *What distinguishes instances in which coaches' use of the practical measure data improves the quality of their debrief conversations from those in which it does not?*

In answering my first research question, I address whether and how coaches' use of practical measures can improve the quality of one-on-one coaching cycles. In answering my second research question, I seek to further clarify the ways in which coaches can use data from the practical measure to improve their debrief conversations with teachers.

Extrapolating to Other Types of Support for Teachers' Learning

While my two research questions focus on one-on-one coaching, investigating these two questions might also have implications for other types of support for teachers' learning. As mentioned previously, this is because analyzing data on instruction in relation to data on students' learning is also central to both effective professional development (e.g., Borko, Jacobs, & Koellner, 2010) and effective teacher collaborative meetings (e.g., Horn & Kane, 2015; Horn et al., 2017). In light of these parallels, finding that coaches' and teachers' use of practical measures can enable them to relate students' thinking to instruction more effectively in one-on-one coaching cycles might well have similar implications for TCT and PD. If this is the case, then it indicates that incorporating practical measures into potentially productive supports for teachers' learning might enhance the quality of those supports, and thus improve teachers' opportunities to develop ambitious instructional practices.

Research Context: Coach Professional Development Design Study

I investigated the aforementioned research questions by examining data collected as part of a professional development (PD) design study that aimed to support mathematics coaches in enacting one-on-one coaching cycles effectively with teachers. One of the objectives of the PD design study was to support the participating coaches in using the aforementioned whole-class

discussions measure as a tool for facilitating the debrief phase of coaching cycles effectively. The PD design study is therefore an appropriate context for this analysis because it aimed to support the participating coaches to use of practical measures in one-on-one coaching cycles.

Overview of Coach Professional Development Design Study

Because the literature on supporting coaches' learning is thin, a researcher team (of which I was a member) partnered with mathematics instructional leaders in a large urban school district to conduct a design study with the goal of supporting middle-grades mathematics coaches in enacting one-on-one coaching cycles effectively with teachers. In the study, the researchers and district leaders collaboratively designed and facilitated a sequence of eight monthly coach PD sessions across a school year. We organized each of the sessions around a key aspect of one-on-one coaching cycles, including, for example, collecting practical measures data during the lesson enactment phase of a cycle and later analyzing those data with teachers during the debrief phase (see Appendix A of the second study of my dissertation for a full list of session topics).

As part of the PD design study, we asked each of the participating coaches to enact a coaching cycle with the same focal teacher after each of the eight sessions. Our intention in doing so was to provide the coaches with an opportunity to try out the ideas discussed in the PD sessions. Over the course of the study, we collected data to document seven of the 15 participating coaches' practices as they enacted coaching cycles with a partner teacher over the course of the school year. We did so in order to track the development of coaches' practices in relation to our goals for their learning, including our goals regarding their use of practical measures. Our ongoing analyses of these data then informed our design of subsequent coach PD sessions. Of note, all seven coaches used practical measures of mathematics instruction in at least

one coaching cycle. In this study, I examined the data we collected to document the seven coaches' developing practices to determine whether and, if so, how coaches' use of the whole class discussion measure can enable them to facilitate higher quality debrief conversations, and thus better support teachers' learning.

Supporting Coaches' Use of the Whole Class Discussion Measure in One-on-One Coaching Cycles. In the fifth session of the coach PD, we introduced the whole-class discussion measure. In this session, we explained the intended focus of each item on the measure, with the goal of supporting coaches to see how each item related to different aspects of whole class discussions. In the subsequent sixth PD session, we supported coaches to facilitate debriefing conversations effectively. As part of this session, we supported coaches to analyze data from the whole-class measure with teachers in the debriefing phase of a coaching cycle. We supported the coaches to analyze the practical measure data with individual teachers in order to determine whether the changes teachers were making to their instruction were improvements. This goal is consistent with the intended uses of practical measures (e.g., Krumm et al., 2016; Hannan, Russell, Takahashi, & Park, 2015; Silva & White, 2017). In line with the conjectures outlined previously, we also supported the coaches to use the practical measure data to support teachers a) in accounting for students' learning with regard to instruction, and b) in identifying areas of improvement that might not have come up otherwise.

Participants

Fifteen school-based mathematics coaches participated in the coach PD design study. Thirteen of the coaches worked in middle schools, whereas two of the coaches worked in high schools. In order to document coaches' development over the course of the PD design study, we

collected data on a sub-set of seven participating coaches' practices as they enacted their coaching cycles with a partner teacher. We selected the seven focal coaches to represent a range in coaching experience and coaching contexts, thereby providing us with useful information on the range of coaching practice in the PD. Six of the seven coaches worked in middle schools, whereas the remaining coach worked in a high school. Of the seven focal coaches, four were novice coaches in their first year of coaching. Two of the seven coaches had at least one year of experience as a school-based mathematics coach in the district. One of the participating coaches had multiple years of experience coaching mathematics teachers, but was in her first year working in the focal district.

As mentioned previously, we asked all fifteen school-based coaches to conduct coaching cycles after each PD session. With this in mind, we asked all 15 coaches to select one focal teacher with whom they would conduct coaching cycles over the course of the school year. The teachers who worked with the seven focal coaches were also participants in the design study. Two of the participating teachers were in their first full-time year as instructors. The remaining teachers had at least three years of teaching experience.

Research Methods

Data Collection

Five data collectors assisted in documenting coaches' practices as they enacted coaching cycles with teachers. These five data collectors included three data collectors external to the project, the project coordinator, and myself. The three external data collectors were a former mathematics coach, a current doctoral student in mathematics education, and a former middle

school administrator. All three data collectors had expertise in both ambitious mathematics instruction and in collecting data on instruction during lesson observations. We conducted an initial training session for the data collectors and the project coordinator in which we explained the purpose of the project and our data collection process. In addition, I accompanied each of the data collectors the first time they collected data to document each of the three phases of a coaching cycle in order to support them in collecting the data effectively.

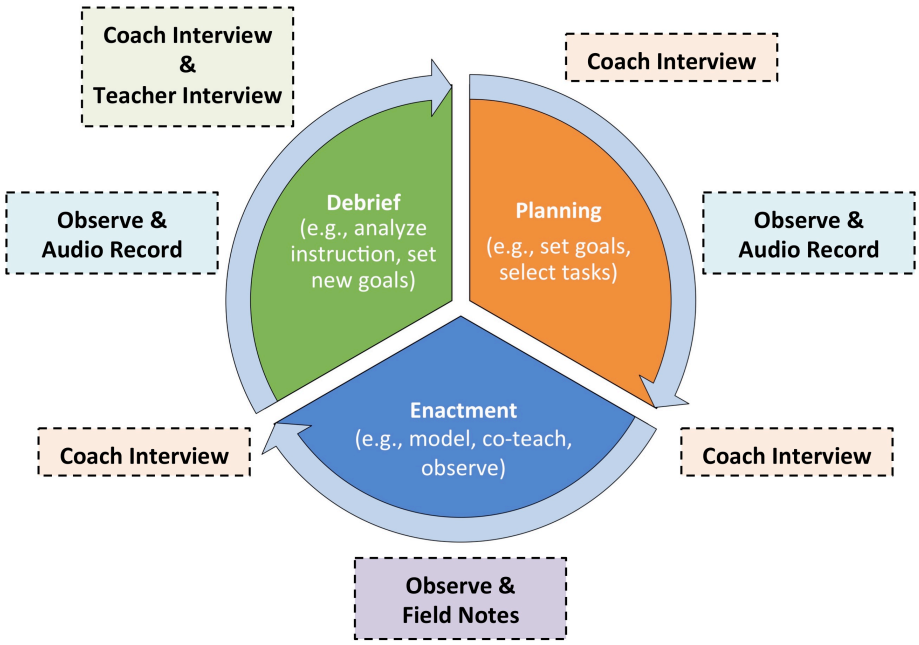
We documented a total of 35 coaching cycles across the school year. Coaches administered the whole-class discussion measure in teachers' classrooms for 14 of the coaching cycles. However, coaches and teachers only analyzed data from the practical measure in 12 of these 14 coaching cycles. In the other two cycles, coaches and teachers ran out of time in their debrief conversations to analyze the data. Therefore, this study focused on the 12 cycles in which coaches and teachers analyzed the data, as the data collected during these cycles enabled me to address my research questions. A single coach-teacher pair accounted for five of the 12 cycles. Another coach-teacher pair accounted for two of the cycles. The remaining five coach-teacher pairs accounted for one each of the other five cycles.

I now briefly describe the nature of the data we collected for each of these cycles, as the types of data available are relevant to my analytic process. Figure 4 (below) outlines our data collection process and highlights the data collected for each phase of a coaching cycle.

At the beginning of each cycle, data collectors conducted an interview to document how coaches had prepared for the co-planning phase. Using an audio-recorded, semi-structured interview protocol, data collectors asked coaches to describe their plans for the upcoming planning conversation, as well as how their plans addressed the improvement goals identified in co-planning or at the end of the previous cycle (see Appendix C of the second study of my

dissertation for all data collection protocols). Data collectors then observed and audio recorded the subsequent planning conversation. Following the planning phase, data collectors conducted a second audio-recorded, semi-structured interview with coaches. The goal of these interviews was to clarify coaches' interpretations of their planning conversations as well as their goals and plans for the upcoming classroom instruction phase. As part of these interviews, data collectors asked about key coaching decisions, such as whether coaches intended to model, co-teach, or observe during the classroom phase, as well as coaches' rationales for those decisions.

Figure 4: Data Collection Process



Following the lesson planning, data collectors observed the enactment of the lesson. Unfortunately, due to IRB concerns, we were unable to videotape or audio-record these lessons. However, data collectors used a structured observation protocol to record field notes detailing key aspects of the focal lesson. One of our goals in collecting these data was to document the

kinds of evidence required to make sense of the topics discussed in the subsequent debrief conversation. To this end, the data collection protocol focused on documenting students' learning opportunities and individual teachers' instructional practices during the lesson.

Specifically, the observation protocol oriented data collectors to: 1) collect the task(s) used in the lesson and document their level of rigor; 2) document how the teacher (or coach) launched the task; 3) document whether the launch enabled all students begin working productively on the task(s); 4) document the range of students' solution strategies by taking notes and taking photos of students' work; and 5) document whether the teacher (or coach) elicited students' reasoning and supported them to make connections between solution strategies during the whole-class discussion. In addition, data collectors collected the practical measure data when the coach and/or the teacher administered the whole-class discussion measure during the focal lesson. This enabled the data collector to understand the evidence of students' learning and of instruction discussed in the subsequent debrief.

After the classroom instruction phase, data collectors conducted a third semi-structured interview with coaches. The goal of these interviews was to understand whether coaches saw evidence that teachers were making progress toward instructional improvement goals. We also aimed to understand what data, if any, the coaches analyzed to reach this determination, including data on students' learning (e.g., students' work) and on instruction (e.g., written field notes, data from practical measures of instruction). If coaches saw evidence of improvement, we also aimed to understand why it constituted progress. Finally, if coaches saw progress, we aimed to understand what coaches identified as new goals for teachers' learning and the data they analyzed to determine those goals. When coaches and/or teachers administered practical measures in the classroom instruction phase, we also asked coaches to share their interpretations

of the resulting data in these interviews. We then asked the coaches to describe how they planned to use the practical measures data with teachers in the subsequent debriefing phase. These interviews provided useful context for understanding how coaches intended to use practical measures in their debrief conversations with teachers.

Next, data collectors observed and audio-recorded the debriefing phase of the coaching cycle. Data collectors then conducted a fourth semi-structured interview with coaches. Our goal for these interviews was to better understand coaches' thinking regarding: a) the data discussed in the debrief; b) why coaches and teachers analyzed that data, if they did; c) whether and how coaches and teachers connected students' learning goals, students' thinking, and instruction in the debriefing conversation; and d) whether the analysis led to the identification of areas for future instructional improvement with the teacher.

Finally, data collectors also conducted semi-structured interviews with the participating teachers after the debrief conversation. The goal of these interviews was to understand teachers' interpretations of what happened during the debrief phase, including their thinking related to: a) the data analyzed during the debrief phase; b) their takeaways about instruction and/or students' learning based on the analysis, if it occurred; and c) whether the analysis led to the identification of areas for future improvement. If coaches and teachers analyzed practical measures data during the debrief, the data collectors also asked teachers to explain whether and, if so, how the practical measures data enabled them in understanding what happened during the lesson.

Focal Data. In this study, I analyzed the 12 cycles in which coaches and teachers used the practical measure. I analyzed the following data to determine whether and how coaches' use of the data enabled them to improve the quality of their debrief conversations with teachers: 1) the evidence collected during classroom observations, 2) audio recordings of the debrief phase,

and 3) interviews with coaches and teachers following the debrief phase. The evidence from the classroom observations provided me with necessary context for making sense of the topics discussed during the debrief phase. For example, having access to the actual practical measures data, students' work, and coaches' notes—in addition to audio recordings from the debrief phase—enabled me to understand whether particular topics were likely to arise absent the practical measures data.

The audio recordings of the debrief phase enabled me to identify episodes in which analyzing the data enabled coaches facilitate higher quality debrief conversations, as well as episodes in which this was not the case. This enabled me to determine whether coaches' use of the measure enabled them to improve the debrief conversations. Comparing instances in which this was the case with those in which it was not enabled me to clarify *how* mathematics coaches used the practical measure data to improve their debrief conversations. Finally, the interviews with coaches and teachers enabled me to further refine my understanding of how coaches used of the practical measures data in the debrief phase. This was because we asked coaches to share their rationale for particular coaching decisions in the coach interviews. We also asked teachers to share their takeaways from the debrief conversation in the post-debrief interview, which provided context regarding how teachers interpreted the use of the practical measure.

Data Analysis

I conducted my data analysis in four phases. The first three phases focused on my first research question (i.e., *Can coaches' use of the practical measure data in one-on-one coaching cycles improve the quality of their debrief conversations with teachers? If so, how?*). The fourth phase focused on my second research question (*What distinguishes instances in which coaches'*

use of the practical measure data improves the quality of their debrief conversations from those in which it does not?). I now discuss each of the phases in turn.

Phase 1: Identify Episodes in Which Coaches and Teachers Discussed Practical Measures Data. In the first phase of my analysis, I identified discrete units of talk in each debrief conversation in which the coach and teacher discussed or directly referenced data from the whole class discussion measure. I operationalized these "episodes" as beginning when the coach or teacher first discussed or referenced data from a particular item on the whole class discussion measure and ending when the coach or teacher shifted the conversation to discuss a new item *or* brought up an idea unrelated to their discussion of the practical measure item. This meant that an episode might include discussions of other data, such as students' work or coach notes, if that talk related to the coach and teacher's analysis of the focal practical measure item. An episode might also include references to other items on the whole class discussion survey, if those references were in relation to the coach and teacher's understanding of the focal item. Across the 12 relevant debrief conversations, I identified 61 episodes in which the coach and teacher discussed student responses to a particular item from the discussion measure.

Phase 2: Characterize the Topics in Episodes Featuring Practical Measure Data. In the second phase of my analysis, I examined the aforementioned 61 episodes in order to characterize what coaches and teachers discussed in these episodes, and thus the topics that emerged over the course of their discussions. By topics, I mean the specific claims, questions, or conjectures that coaches and teachers referenced in a particular episode. To conduct this coding, I first developed a set of inductive codes based around coaches' and teachers' own language. For example, I coded the following passage using the codes, "the teacher featured students' strategies in the whole class discussion" and "the teacher did not show her own strategy to solve the task":

> Good and I think you, you had stepped back a lot with that too and you didn't show them one of your ways. You showed them other students' ways… You actually showed the [a student's] work under the [document camera].

After engaging in this initial round of coding for all 61 episodes, I then developed a more refined coding scheme that described the *types* of topics coaches and teachers discussed. I did so by analyzing across my initial inductive codes, and organizing the codes into categories. I then coded each of the 61 episodes with this more refined coding scheme. For example, I coded the passage referenced above using the code, "topic type – aspect(s) of instruction – what the teacher did in the lesson."

When relevant, I aligned codes for the types of topics discussed in the episodes with terminology used in the coaching literature and with the language used in my two conjectures regarding coaches' use of practical measures. This meant that I used the code "topic type – account for students' learning with regard to instruction" to describe claims, questions, or conjectures in which the coach or teacher made a connection between aspects of instruction in the lesson and what students learned in the lesson, thereby explaining *why* students learned what they learned. I used the code "topic type – areas for improvement" to describe topics in which the coach or teacher a) noted something that went well in the lesson *and* suggested the teacher should continue to do that in future lessons or b) noted something that did not go well in the lesson *and* suggested they make particular changes in instruction to address that weakness in future lessons.

Phase 3: Determine Whether and How Analyzing the Practical Measure Data Improved the Quality of the Debrief. In the third phase of my analysis, I examined the 61 relevant episodes to identify those in which discussing the practical measure data improved the

quality of the debrief conversation, beyond enabling coaches and teachers to determine whether a change in instruction was an improvement. I used two criteria to identify these episodes:

1. The episode involved topics that *emerged directly from* coaches' and teachers' discussions of the practical measure data, and were unlikely to have arisen without the data
2. The episodes involved topics coded as either a) accounting for students' learning with regard to instruction or b) identifying instructional strengths and/or areas for improvement

Taken together, these two criteria enabled me to identify episodes in which the practical measure data were central to coaches' and teachers' analyses of focal lessons, and those analyses were characteristic of high-quality debrief conversations.

I used a three-step process to determine whether episodes satisfied my first criterion. First, I compared my initial topic codes for each episode with the intended focus of the practical measure item, as defined by the developers of the measure (see Appendix A). I did so to determine whether the claims, questions, or conjectures in the episode related directly to the intended focus of the item. Second, I compared the topics that related directly to the intended focus of the practical measure item with the other data available to the coach and teacher in the debrief conversation. I did so in order to assess whether, in all likelihood, the topics could have emerged by analyzing these other data. Lastly, I compared the topics with the issues that the coaches and teachers discussed in the debrief conversations *prior to* their analysis of the practical measure data. I did so to determine whether coaches and teachers raised the focal topics prior to looking at students' responses to the relevant practical measure item. I determined that episodes satisfied my first criterion when they included topics that directly related to the practical measure

item *and* the topics would not, in all likelihood, have come up by discussing the other data available to the coaches and teachers.

To address my second criterion, I drew upon my coding from phase 2 of my analysis. I determined that episodes satisfied my second criterion when there was evidence that coaches and teachers had either a) accounted for students' learning with regard to instruction or b) identified areas for improvement as they discussed students' responses to the relevant practical measure item. I retained only those episodes that satisfied both of my criteria. To conclude this phase of my analysis, I used the constant comparative method (Corbin & Strauss, 2015) to identify similarities and differences in the processes by which coaches and teachers used the data from the practical measure to better account for students' learning with regard to instruction, as well as similarities and differences in how coaches and teachers used the data to identify areas for improvement.

Phase 4: Compare Coaches' and Teachers' Use of the Practical Measure. Whereas the previous three phases of my analysis enabled me to answer my first research question, the fourth phase of my analysis enabled me to answer my second research question. In this phase, I compared episodes classified as improving the quality of the debrief conversation (i.e., those that satisfied both of the criteria from phase three) with those classified as not improving the debrief conversation. Because little is known about how coaches can use practical measures in coaching, I again used the constant comparative method (Corbin & Strauss, 2015) to compare the two types of episodes. In doing so, I focused on coaches' actions and teachers' responses to those actions in the particular episodes. This enabled me to identify distinctions in coaches' and teachers' uses of the data based on whether their discussions of the data improved the debrief conversation.

Findings

In what follows, I report on my findings for each of my two research questions.

Question 1: Can coaches' use of the practical measure data in one-on-one coaching cycles improve the quality of their debrief conversations with teachers? If so, how?

I identified 61 distinct episodes in which individual coaches and teachers discussed or referenced data from a practical measure item as part of the debrief conversations. In 12 of these episodes, there was evidence that coaches' and teachers' use of the practical measure data improved the quality of the debrief conversation. All 12 episodes occurred in debrief conversations facilitated by the two coaches who used the practical measure most frequently in their coaching work. In eight of the 12 episodes, there was evidence that discussing the data enabled the coaches and teachers to better account for students' learning with regard to instruction. In the remaining four the episodes, there was evidence that discussing the practical measure data enabled the coaches and teachers to identify productive areas for improvement that would, in all likelihood, not have come up without the data.

There was no indication that discussing the practical measure data improved the quality of the debrief conversation in 49 of the 61 episodes. In 35 of these episodes, the coaches and teachers used the practical measure data to assess whether the lesson was an improvement over previous lessons. In one episode, for example, the coach and teacher briefly reviewed students' responses to an item. The teacher then noted, "I like that… pretty cool." In response, the coach added, "Yeah, that's awesome," and the two moved on to another item. In all 35 episodes, this use of the data did not result in the types of analysis characteristic of high quality debrief conversations.

In the remaining 14 episodes, there was evidence that analyzing the practical measure data had the *potential* to improve the quality of the debrief conversation, but that this potential was not realized. In each of these episodes, analyzing the data resulted in topics that would not have come up without the data, beyond just assessments as to whether the lesson was an improvement. However, in discussing these additional topics, coaches and teachers did not account for students' learning with regard to instruction, nor did they identify areas for improvement. In one episode, for example, the coach and teacher analyzed students' responses to the practical measure item reading, "What was the purpose of today's whole class discussion?" In this episode, analyzing the data enabled the coach and teacher to discuss what students saw as the purpose of sharing their solution strategies in the concluding whole class discussion. Specifically, the coach and teacher observed that, based on the data, students were beginning to see that discussions provided an opportunity for them to understand others' reasoning, rather than just check to see if they got right answers. This observation tied directly to the focal practical measure item, and the coach and teacher did not have access to other data related to this topic, indicating the coach and teacher were unlikely to discuss this topic without the data.

Unlike the 12 episodes in which discussing the data improved the quality of the debrief, the coach and teacher did no capitalize on this topic to either account for student students' learning with regard to instruction or identify an area for improvement. As discussed below, they might have done so by relating students' responses to the practical measure item with a specific aspect of the teacher's instruction, as doing so appeared to be a necessary step in using the data to both better account for students' learning with regard to instruction or identify areas for improvement that they would not have without the data. This type of missed opportunity is

representative of all 14 episodes in which an opportunity to improve a debrief conversation was not realized.

I now further discuss the 12 episodes in which there was evidence that coaches' and teachers' use of practical measure data improved the quality of the debrief conversation. In discussing these episodes, I focus on my two conjectures regarding how coaches' use of the measure might enable them to facilitate higher quality debriefs than they otherwise would have.

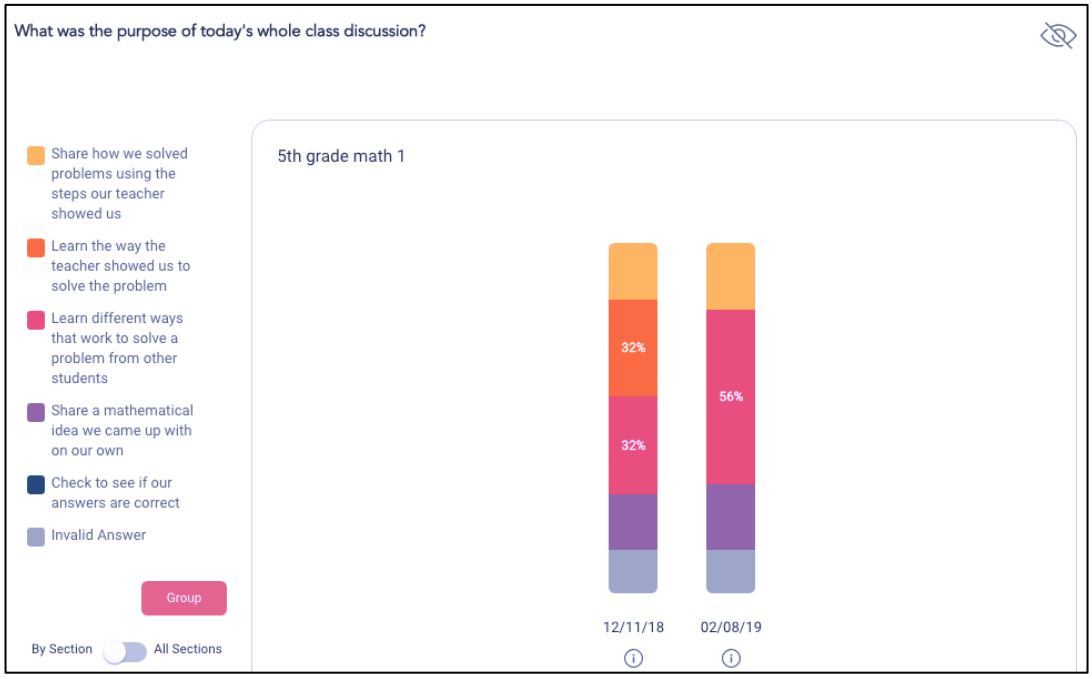
Conjecture 1: Better Account for Students' Learning Opportunities with Regard to Instruction. In eight of the 12 episodes, coaches' and teachers' analysis of the practical measure data enabled them to better explain how instruction influenced students learning and learning opportunities in the lesson. All eight episodes involved a similar process. First, the coaches and teachers discussed students' responses to an item on the whole class discussion measure by relating those responses to an aspect of the teacher's instruction in the lesson, such as what the teacher did to try to help listening students make sense of other students' explanations in the whole class discussion. In doing so, the coaches and teachers focused on an aspect of instruction that would not, in all likelihood, have emerged as a topic of discussion without the data. Second, coaches and teachers discussed how that aspect of instruction influenced students' learning or learning opportunities in the lesson, drawing on evidence of students' thinking and learning in the lesson to do so.

While this process was generally consistent across all eight of the episodes, there was variation with regard to who initiated the analysis and the types of additional data on which the coaches and teachers drew to make their claims about instruction and students' learning. Acknowledging this variation, I give an illustration in order to further clarify this process. I

selected this illustrative episode because it is representative of the process by which all eight episodes unfolded.

Illustrative Episode: Susan and Kim. In this episode, a coach, Susan, and a teacher, Kim, compared students' responses to the item "What was the purpose of today's whole class discussion?" with students' responses to the same item from the previous lesson (see Figure 6 below). As outlined in Appendix A, this item of the practical measure is designed to provide information on what students see themselves as accountable for doing in the whole class discussion. Students' response options for this item include: share how we solved problems using the steps the teacher showed us; learn the way the teacher showed us to solve the problem; learn different ways that work to solve a problem from other students; share a mathematical idea we came up with on our own; and check to see if our answers are correct.

Figure 5: Students' Responses to Relevant Practical Measure Item (Susan and Kim)



In this particular episode, Susan and Kim first related the practical measure data to a particular aspect of instruction. They did so by looking at changes in students' responses between two lessons, and then relating those changes to a change Kim made in her teaching. Specifically, Susan noted that there was a substantial increase in the percentage of students responding, "learn different ways that work to solve a problem from other students." Kim agreed, and pointed out that fewer students indicated the purpose of the discussion was to "learn the way the teacher showed us to solve the problem." Susan then noted that some students might have changed their responses because Kim had called on students to share their strategies in the discussion, rather than simply sharing her way of solving the task. In making this observation, Susan focused an aspect of Kim's instruction that, based on my analysis of the other data available to Susan and Kim for the debrief conversation, was unlikely to have come up absent the practical measure data. Of note, they also both agreed that the change in students' responses was positive, indicating that they used the data to determine whether a change that Kim had made in. her instruction was an improvement.

Having related the change in students' responses to a change in Kim's instruction, Susan and Kim then discussed the implications of that change for students' learning. Susan initiated this second step in the process by asking Kim to explain why she had decided to make this change in her teaching. Kim explained that she decided to elicit students' strategies in the discussion rather than teach a single strategy because wanted to support students in seeing connections between their different approaches to the task. Kim then noted that, overall, students had made progress in solving the task using varied strategies, as evidenced by their work. She also noted that there were still some students who required additional support in understanding the connections between the various strategies. Kim attributed students' struggles to her

inexperience in facilitating discussions in which students share their own ideas, noting she was just beginning to feel comfortable facilitating those types of discussions. In making this last point, Kim linked the focal aspect of instruction with the developments she had seen in students' thinking over the course of the lesson.

As this episode illustrates, using the practical measure data to better account for students' learning with regard to instruction appears to involve two steps. First, coaches and teachers discuss the practical measure data in relation to a particular aspect of the teacher's instruction in the lesson, as Susan and Kim did. Second, coaches and teachers then relate that aspect of instruction to students' learning, in the process linking the aspect of instruction with developments in students' thinking. This process contrasts with coaches' and teachers' use of the data in episodes for which there was evidence of unrealized potential to improve the quality of the debrief conversation. In these latter episodes, coaches and teachers discussed topics that would not have come up without the data, but they did not make the transition to linking the practical measure data with specific aspects of instruction.

Conjecture 2: Identify Areas for Improvement. In four episodes, discussing the practical measure data enabled the coaches and teachers to identify areas for improvement that would not otherwise have come to the fore. All four episodes involved a similar process, though it was curtailed in one episode. Coaches and teachers first identified a weakness in the lesson based on students' responses to the practical measure item. They then framed the weakness as indicative of a weakness in the teacher's instruction, thereby relating the data to a specific aspect of instruction. Finally, coaches and teachers proposed specific changes in instruction that they planned to make in future lessons in order to address the identified weaknesses.

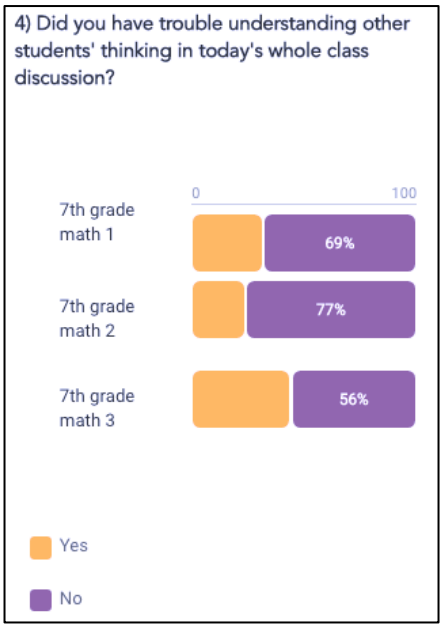
In the episode in which this process was curtailed, the coach and teacher looked at the change in students' responses over time on the item, "Did listening to other students in today's whole class discussion help you make your thinking better?" In looking at the data, the coach and teacher observed that the majority of students had yes for the previous lesson, but the majority of students said no for the most recent lesson. The teacher then immediately responded to this observation by suggesting an instructional change she wanted to make to address the downturn in students' responses. In this episode, the teacher therefore posed a change in instruction without explicitly articulating an instructional weakness in the lesson. This was the fifth time the teacher had analyzed the practical measure data with the coach, and due to her familiarity with the data analysis process, she may have condensed the process for identifying an area for improvement. As I explain in my discussion section, this is a significant development that constitutes a goal for teachers' learning

In addition to the aforementioned variation, there was also variation in these four episodes with regard to who identified the weakness in the data, who positioned the weakness as related to an aspect of instruction, and who proposed the change in instruction. Acknowledging these variations, I now give an illustration of how analyzing the data enabled coaches and teachers to identify areas for improvement that would not otherwise have come up. Again, I selected this illustrative episode because it is generally representative of the process by which the majority of the episodes unfolded.

Illustrative Episode: Joy and Eleanor. In this episode, a coach, Joy, and a teacher, Eleanor, discussed students' responses to the practical measure item, "Did you have trouble understanding other students' thinking in today's whole class discussion?" This item is intended to assess whether students could make sense of other students' ideas in a whole class discussion.

In the episode, Joy and Eleanor compared the responses of students from three different classes. Eleanor had taught the same lesson in all three classes on the same day (see Figure 7, below).

Figure 6: Students' Responses to Relevant Practical Measure Item (Joy and Eleanor)



The episode began with Joy asking Eleanor, "What do you think that the yeses there were?" In doing so, Joy pointed out a weakness in the lesson, particular for the third class: a significant proportion of students reported that they had difficulty in understanding other students' thinking in the whole class discussion. Responding to Joy's question, Eleanor initially suggested that her students responded yes because middle school students often struggle to explain their ideas clearly. On her own, she then adjusted her interpretation to frame the students' responses as a result of an instructional weakness. Specifically, Eleanor explained that students might have also struggled to understand other's explanations in the discussion because she had not taken an active enough role in facilitating the discussion. In making this suggestion,

Eleanor framed the data as indicative of a weakness in her instruction, and thus something she could address by improving a specific aspect of her instruction. In doing so, she related students' responses to the particular practical measure item to a specific aspect of her instruction.

Joy then suggested a particular change that Eleanor might make in her teaching. She proposed that Eleanor might introduce students to a set of conversation routines that they could use to question one another, with the goal of helping explaining students clarify their explanations. Eleanor indicated that she agreed with this suggestion, and noted that she had thought about a similar approach in the past. Eleanor then noted that *she* could also ask questions during the discussion to more actively support students in explaining their ideas clearly. This indicated that Eleanor wanted to address the weakness in the lesson, and thus saw the weakness as an area for future improvement.

As this episode illustrates, using the practical measure data to identify an area for improvement appears to involve three steps. First, coaches and teachers identify a weakness in the lesson based on their interpretation of the data, as Joy did in the above illustration. Then, coaches and teachers frame the weakness as one related to instruction, thereby relating the practical measure data to specific aspects of instruction. Eleanor did this in her second explanation for why some students responded yes to the focal item. This results in coaches and teachers identifying an instructional weakness that would not have come up without the data. Finally, coaches and teachers propose specific changes in instruction that they might make in subsequent lessons to address the identified weakness. As I note below, this process contrasted with those episodes in which there was evidence of unrealized potential to improve the debrief conversation. In episodes for which there was evidence of unrealized potential, coaches and

teachers did not connect student responses to specific aspects of instruction. As a result, they did not position less desirable data as indicative of specific instructional weaknesses in the lesson.

Question 2: ***What distinguishes instances in which coaches' use of the practical measure data improves the quality of their debrief conversations from those in which it does not?***

To answer this question, I compared the 12 episodes in which coaches' use of the practical measure data improved the debrief conversation with the 14 episodes in which the potential for improvement was not realized. I did not include those episodes in which coaches and teachers only used the data to determine whether the lesson constituted an improvement, as those episodes were distinguishable by the very nature of the coach and teacher's analysis.

I found that coaches pressed teachers to link students' responses to survey items with aspects of their instruction in those episodes in which their use of the practical measure data improved the debrief conversation. There was no evidence of this occurring in the episodes in which the potential to improve debrief conversations was not realized. More specifically, I found that coaches pressed teachers to relate students' responses on the practical measure to instruction in ten of the twelve episodes for which there was evidence that discussing the data improved the debrief conversation. This process was curtailed in the remaining two episodes, both of which featured the same coach-teacher pair. In one episode, the teacher related the practical measure data to her instruction without press from her coach. In the other episode, which I described previously, the teacher posed an area for improvement without first explicitly relating the practical measure data to an aspect of her instruction. As a consequence, coach press appeared unnecessary in these two episodes. In contrast, there was no evidence of this kind of press in the 14 episodes in which discussing the data resulted in unrealized potential. Notably, this finding is

consistent with and expands upon the work of Matsumura and colleagues (2019), who argued that effective facilitation of debrief conversations includes pressing teachers to explain their reasoning using evidence from the lesson.

Distinctions in Coach Press. I identified four ways in which coaches pressed teachers to connect the practical measure data with instruction. In four of the ten episodes, coaches pressed teachers to link the data with instruction by first making a conjecture about why students responded the way they did (e.g., " I wonder…"), and then eliciting teachers' responses to the conjecture (e.g., "What do you think?"). In three of the ten episodes, coaches asked an explicit question that prompted teachers to explain why students responded the way they did (e.g., "Why do you think students responded that way?"). In all three episodes, this appeared to lead teachers to interpret the data in relation to particular aspects of instruction. In two of the ten episodes, coaches pressed teachers to explain why students' responses to particular survey items changed over time. Again, this appeared to lead teachers to connect students' responses to aspects of instruction in the lesson. Finally, in one episode, the coach asked the teacher to explain why she thought students' responses indicated that the lesson was a success. In explaining her rationale, the teacher connected students' responses to a particular aspect of her instruction.

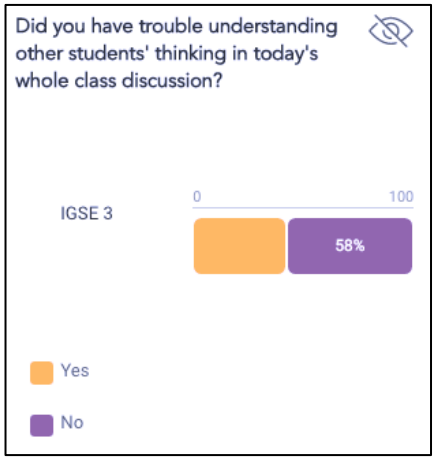
In two of the 14 episodes for which there was evidence of unrealized potential, the same coach did press on her teacher's thinking, asking the teacher to share her interpretation of the lesson based on the student response data. In both of these episodes, however, this appeared to prompt the teacher to make broad statements about the lesson, rather than connect the data with specific aspects of instruction. In one episode, for example, the coach and teacher looked at students' responses to the item, "What did you need to do in order to be successful in your math class today?" In this case, most students said, "Listen to and make sense of other students'

reasoning," rather than "Solve problems using the steps the teacher showed me." After looking at the data together, the coach asked, "What are your takeaways?" The teacher explained that students' responses indicated she "taught [the lesson] well," according to what she had learned about math instruction. The coach agreed, and they moved on to the next practical measure item.

This distinction in coach press is significant, because relating the practical measure data to specific aspects of instruction is critical if coaches and teachers are to better account for students' learning with regard to instruction or identify areas for improvement based on the data. Distinctions in whether and how coaches press teachers to relate the data to aspects of instruction might therefore explain why some episodes resulted in unrealized potential to improve the debrief conversation. With this in mind, I now describe a sample episode to illustrate how the absence of coach press resulted in unrealized potential to improve the quality of the debrief conversation.

Illustrative Episode: Jess and John. In this episode, a coach, Jess, and a teacher, John, analyzed students' responses to the practical measure item, "Did you have trouble understanding other students' thinking in today's whole class discussion?" Figure 8 (below) shows students' responses to this particular item.

Figure 7: Students' Responses to Relevant Practical Measure Item (Jess and John)



As background this episode, Jess asked John to predict students' responses to each of the practical measure items prior to looking at students' actual responses. In the focal episode, Jess first asked John to compare his prediction regarding students' responses with students' actual responses to the item. Earlier in the conversation, John had explained that he expected 75% of his students to say they understood other students' thinking, as this was something he both aspired to accomplish in his instruction and attempted to accomplish in the focal lesson. In looking at the actual responses, John noted that almost half of his students had trouble understanding other students' thinking in the whole class discussion, which was significantly more than he had predicted. John viewed students' responses as both surprising and problematic. Analyzing the data therefore resulted in a John identifying a weakness in the lesson that would not have come up without the data.

At this point, Jess could have pressed John to explain why his students responded the way they did, much as Susan had pressed Kim in a prior illustrative episode. In the episodes that Susan and Kim's exchange illustrated, coaches' press prompted teachers to relate students' responses to practical measure items to specific aspects of their instruction. This then initiated exchanges in which the coaches and teachers either accounted for students' learning in terms of instruction or identified an area for improvement. In this episode, however, Jess pointed John to the next item on the survey, rather than pressing him to relate students' responses to a specific aspect of instruction. If Jess had made a different decision, then it is possible that she could have supported John in connecting the practical measure data to a specific aspect of instruction in the lesson. This might have then enabled her to support John to either better account for students' learning with regard to instruction or to identify an area for instructional improvement. For example, it is possible that connecting the students' responses to this particular item with a

specific aspect of the lesson would have aided John in identifying a weakness *in his instruction*, much as Joy had aided Eleanor. Instead, Jess and John missed the opportunity to engage in that kind of discussion.

As this episode illustrates, whether coaches pressed teachers to relate students' responses to aspects of instruction may explain why some discussions of the practical measure data resulted in improvements in the debrief conversation, whereas others resulted in unrealized potential. This is significant because explaining students' responses to particular practical measure items in detail appeared to initiate exchanges in which coaches and teachers related the practical measure data to specific aspects of instruction. This appeared to be a necessary step in using the data to both account for students' learning with regard to instruction and identify areas for improvement. Supporting teachers to make this kind of connection therefore appears critical to whether coaches' and teachers' use of the practical measure enabled them to improve the debrief conversation.

Discussion

The primary goal of this study was to understand whether and, if so, how coaches' use of a practical measure of high-leverage aspects of instruction can enable them to be more effective in supporting teachers through one-on-one coaching than would otherwise be the case. The findings of my analysis indicate that coaches' use of the practical measure in one-on-one coaching cycles can enable them to be more effective in supporting teachers' learning. More specifically, there was evidence that discussing the practical measure data in the debrief phase of coaching cycles can enable coaches and teachers to a) better account for students' learning with regard to instruction and b) identify productive areas for improvement that would not have come

up without the data. These findings substantiate my conjectures regarding how coaches' use of the practical measures might enable them to better support individual teachers' learning. Additionally, I found in the cases in which discussing the data improved debrief conversations, coaches pressed teachers to relate students' responses to the practical measure to aspects of their instruction in the focal lesson. This finding underscores that whether coaches' use of the practical measure improves their effectiveness in supporting teachers' learning depends crucially on their expertise in using the resulting data.

These findings are significant for research on practical measures in education. By design, practical measures are intended to enable users to determine whether specific changes to practice are improvements (Yeager et al., 2013). In coaching, for example, coaches and teachers can analyze students' responses to practical measures of instruction to determine whether the changes teachers are making to their instruction are improvements. However, my findings highlight two additional contributions of the focal practical measure of instruction, over and above determining whether a change is an improvement; namely, that discussing the data with teachers can enable coaches and teachers to better account for students' learning with regard to instruction and identify productive areas for improvement. This is, to my knowledge, the first empirical study to report on additional contributions of practical measures.

While the contributions identified in this analysis are specific to coaching, they might apply to two other types of support for teachers' learning: professional development and teacher collaborative meetings. This is because high-quality enactments of professional development and teacher collaborative meetings also involve accounting for students' learning with regard to instruction (e.g., Borko, Jacobs, & Koellner, 2010; Horn & Kane, 2015; Horn et al., 2017). Because there was evidence that coaches' and teachers' use of the practical measure data enabled

them to connect students' learning and instruction more effectively than would otherwise have been the case, it is plausible to suggest that the use of the practical measure might prove similarly beneficial in these other supports for teachers' learning. Further research is needed to determine whether this is the case.

This analysis also contributes to the literature on coaching. Specifically, my findings clarify what coaches need to know and be able to do to use practical measure data effectively in one-on-one coaching. As noted above, I found that pressing teachers to interpret students' responses to the practical measure *in relation to* their instruction was central to using the data to improve debrief conversations. Of note, this kind of analysis is characteristic of a conceptual approach to data use (Murnane, Sharkey & Boudette, 2009), in that it involves coaches supporting teachers to "consider explanations and explore solutions" based on data (Moss, 2016, p. 237). Specifying this aspect of coaching expertise serves to clarify a possible goal for supporting coaches' learning that can orient the design of professional development aimed at supporting coaches in using practical measures effectively.

Finally, my findings raise the possibility that coaches might be able to support teachers in learning to interpret and respond to practical measure data independently and effectively. This was evident in the work that occurred between the coach and teacher who used the practical measure in five successive cycles. In the first three of their five coaching cycles, the coach actively supported the teacher to relate students' responses to the practical measure to specific aspects of her instruction. Although the coach continued to provide support in the final two cycles, there was also evidence that the teacher began to interpret students' responses in relation to aspects of her own practice independently of coach press. Moreover, in the final cycle, the

teacher identified an area of improvement based on the practical measure data without significant support from her coach.

These observations indicate that the teacher's participation in analyses of her lessons with her coach supported her in learning to use practical measures data to account for her students' learning in terms of instruction, and thus identify areas for improvement. This then suggests that teachers could, with appropriate support, develop practices for analyzing and interpreting data from practical measures of instruction productively, and that this capability might enable them to improve their instructional practices on an ongoing basis. Future studies might take my findings as a starting point for investigating how to support the development of this capability.

In sum, my analysis clarifies two contributions of the focal practical measure of instruction for one-on-one coaching, over and above the intended contribution of practical measures. Specifically, I found that coaches' and teachers' use of the practical measure in one-on-one coaching cycles can enable them to a) better account for students' learning with regard to instruction, and b) identify productive areas for instructional improvement that would not have come to the fore otherwise. However, coaches' use of the practical measure data can enable them to improve their coaching only *when they press and support teachers to account for students' learning in terms of instruction*. Ultimately, this underscores that practical measures can augment expertise in supporting teachers' learning, but cannot replace it.

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APPENDIX A

Annotated Version of Whole Class Discussion Student Survey

Aspects of whole-class discussions that research indicates make a difference for students' learning opportunities *Items are assessing students' perceptions of…*	**Survey items**
Cognitive demand of the task as implemented We draw on Stein and Lane (1996) to define cognitively-demanding tasks as tasks that can be solved in multiple ways, that offer opportunities for students to explain and justify their reasoning, and/or that prompt students to represent a mathematical relationship in multiple ways. Absent multiple strategies, it is difficult to press students to make connections between mathematical strategies – and doing so is pivotal in deepening students' conceptual understandings of mathematical ideas (Stein & Lane, 1996). To ensure that students are engaging in cognitively demanding tasks, it is important to both choose cognitively demanding tasks *and* maintain the rigor of the task during a lesson. Research indicates that it is common for the cognitive demand of a task to be lowered across the course of a lesson (Stein & Lane, 1996); e.g., teachers might suggest a procedure for students to solve the given task. Students' responses to these items may provide information about how the task was *implemented*, and/or the cognitive demand of the task chosen for the lesson.	**Item 1** What did you need to do in order to be successful in your math class today? □ Solve problems using the steps the teacher showed me □ Listen to and make sense of other students' reasoning **Item 2** Was there only one right way to solve the problem(s) today? □ Yes □ No
What students are accountable for in the discussion Mathematics discussions frequently focus on evaluating whether students' answers are correct (Cazden, 2001). Focusing exclusively on answers is unlikely to present students with opportunities to grapple with and make sense of other students' ideas, because answers alone provide little insight into students' thinking process. We have found that attending to students' views of what they are accountable for in a discussion can provide useful information about the extent to which discussions focus on students' thinking.	**Item 6** What was the purpose of today's whole class discussion? □ Share how we solved problems using the steps our teacher showed us □ Learn the way the teacher showed us to solve the problem □ Learn different ways that work to solve a problem from other students □ Share a mathematical idea we came up with on our own □ Check to see if our answers are correct *Note: We have found it useful to collapse options 1, 2, and 5 as "producing correct answers" and, separately, options 3 and 4 as "sense-making."*
Opportunities for students to listen to, reason about, and make sense of others' ideas Productive discussions involve students sharing their own ideas and strategies for solving problems (Cobb, Yackel, & Wood, 1989). While having students share ideas is an essential aspect of mathematically productive discussions, sharing ideas alone does not guarantee that students' understanding of key mathematical ideas is	**Item 4** Did you have trouble understanding other students' thinking in today's whole class discussion? □ Yes □ No

advanced (Ball, 2001). It is also important that the teacher *presses students to explain and justify their reasoning in ways other students will understand* (Cobb, 1998). For example, it is crucial that students both describe how they solved the problem and explain why they solved the problem the way they did (Kazemi and Stipek, 2001).	**Item 5** Did listening to other students in today's whole class discussion help make your thinking better? □ Yes □ No
Establishing a classroom culture in which students want to share their ideas and feel their ideas are valued Engaging all students in productive discussion is hard work. It requires establishing a classroom culture in which all students see value in sharing their ideas and feel their ideas are valued. This involves negotiating norms regarding how students should treat each other and mathematical ideas (Horn 2012; Kazemi & Stipek, 2001). For example, it is important that students see value in listening to one another and view mistakes as opportunities for learning, rather than as something to be embarrassed about (Horn, 2012; Kazemi & Stipek, 2001).	**Item 3** Were you comfortable sharing your thinking in today's whole class discussion? □ Yes □ No
Centering students' thinking in instruction Productive discussions involve students sharing their strategies for solving problems and making sense of other students' explanations (Cobb, Yackel, & Wood, 1989). While it is important that teachers facilitate discussions, the conversation should build on students' current ways of thinking. Therefore, students typically do most of the talking in productive whole-class discussions.	**Item 7** Who talked the most in today's whole class discussion? □ Students □ The teacher

Note: The annotated survey represents my thinking, as well as the thinking of Hannah Nieman, Kara Jackson, Paul Cobb, and the other members of the Practical Measures, Routines, and Representations (PMRR) team.

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