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Focusing on Teacher Learning Opportunities to
Identify Potentially Productive Coaching Activities

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Abstract

Instructional improvement initiatives in many districts include instructional coaching as a primary form of job-embedded support for teachers. However, the coaching literature provides little guidance about what activities coaches should engage in with teachers to improve instruction. When researchers do propose activities, they rarely justify why those activities might support teacher learning. Drawing on the pre-service and in-service teacher education literatures, we present a conceptual analysis of learning activities that have the potential to support mathematics and science teachers to improve practice. We argue that our analysis can inform research on mathematics and science coaching, coaching policies, and the design of professional learning for coaches.

Keywords: professional development, teacher learning, content-focused coaching, teacher leadership

Instructional coaching is an important component of teachers' professional development. Coaching involves teachers working with a more accomplished colleague as a primary form of job-embedded support to improve instructional practices (Campbell & Malkus, 2011; Coburn & Russell, 2008). This form of professional development is one of the fastest growing across the United States (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009). In fact, state-level officials have responded to this growth by developing endorsements in instructional coaching (for example currently eighteen states have approved mathematics specialists certification, with an additional eight states in process; see mathspecialists.org). These states have charged university educators with designing curricula for supporting future coaches. Similarly, district content specialists in these states and beyond are charged with specifying coaching responsibilities and designing learning opportunities to support coaching practices. Both groups are required to address the question: What do coaches need to know and be able to do to support teacher learning?

There is a growing body of research on various aspects of the role of instructional coaches. Studies have examined coaches' identity development (Rainville & Jones, 2008), the politics of coaching (Coburn & Woulfin, 2012), and the conditions that support coaching, such as the role that principals and districts play in coaching (Gibbons, Garrison, & Cobb, 2011; Coburn & Russell, 2008; Mangin, 2007). Large-scale studies have shown that the implementation of instructional coaching in literacy and in mathematics is correlated with an increase in teacher efficacy (Cantrell & Hughes, 2008), improvements in teaching (Neuman & Cunningham, 2009), and increased student achievement outcomes as measured by standardized tests (Campbell & Malkus, 2011). While research on instructional coach increasingly provides evidence of the impact of high quality coaching, little is known about how accomplished coaches

actually work with teachers. The goal of this article is to address this gap in the coaching research literature by reporting on a conceptual analysis that aimed to identify *potentially productive coaching activities*.

The central questions that framed the analysis are: What does high-quality instructional coaching look like? What activities and practices reliably result in improvements in teachers' actual practice and thus in student learning? The current research base on effective coaching activities is relatively thin. The extant literature suggests that coaching appears to be highly personal and idiosyncratic, with coaches' practices varying significantly from school to school and district to district (Coburn & Russell, 2008). A few empirical studies have been conducted that use survey data to understand the activities typically performed by coaches (Bean, Draper, Hall, Vandermolen, Zingmond, 2010; Deussen, et al., 2007). Coaches can refer to a small collection of books written by practitioners (e.g., Aguilar, 2013; West & Cameron, 2013), but in general, these books are not the result of empirical studies of effective coaching but rather, the products of talented and experienced practitioners. In general, neither the studies nor the books describe whether and how the activities supported teachers' learning. Thus these resources do not answer the needs of states and teacher education institutions that seek to provide training in effective coaching.

Further, the activities in these studies and books typically focus on coaches working with individual teachers, however several researchers have suggested that one-on-one coaching alone may not build collective capacity, an important aspect of school improvement (Lord et al., 2003, 2008; Mangin & Dunsmore, 2015). Furthermore, state and district policies increasingly expect coaches to work regularly with groups of teachers. Thus, an important aspect of coaches' work,

which is largely missing from the current coaching literature, is to lead groups of teachers as they investigate and improve instructional practices together.

Although there is a shared belief that instructional coaches can be a key lever for improvement (Bryk et al., 2013), there is no agreement on the technical core of instructional coaching. This is problematic as coaching endorsements and initiatives require significant resources. The goal of this article is to address this gap in the coaching research literature by conducting a conceptual analysis that aimed to identify *potentially productive coaching activities*. Given the limitations of the coaching literature, we drew on literature on teacher learning activities that has analyzed what teachers have opportunities to learn as they engaged in such activities. Numerous empirical studies in the *teacher education literature* describe the learning activities in detail and attend to what preservice or in-service teachers have opportunities to learn.

We acknowledge that instructional coaching contexts differ in some ways from teacher education preservice and in-service settings. For example, in the studies from which we drew our findings, facilitators of in-service professional development frequently came from outside the district or school and were thus less familiar with the contexts in which teachers worked. In addition, both they and facilitators of pre-service courses were often not familiar with teachers' current instructional practices and may not have provided follow up support for teachers in classrooms.

In contrast, coaches who are typically familiar with other school and district improvement initiatives (e.g., adopted curriculum and pacing guides, principals' instructional expectations for teachers, and other supports for teachers' learning) can observe teachers' instruction and work one-on-one with teachers as well as with groups of teachers. It could be argued that instructors of preservice courses might have additional leverage because of their

status (e.g., preservice teachers have to comply in order to receive a grade). In contrast, coaches need to develop trusting relationships with the in-service teachers they are charged with supporting (Neufeld & Roper, 2003).

Despite these differences in the contexts of professional development and content-focused coaching, there is a deeper structural parallel that justifies drawing on the teacher education literature to identify potentially productive coaching activities. Professional development facilitators, teacher educators, and coaches are all more accomplished others whose goal is to support teachers in improving the quality of their instructional practices.

At present, practitioners and policymakers aiming to implement coaching programs cannot turn to a body of research on effective coaching activities and practices. Furthermore, researchers who investigate coaching initiatives cannot draw on prior work that specifies the types of coaching activities that have the potential to be effective. By drawing on the teacher education literature, we were able to identify a number of coaching activities that have the potential to support teachers' development. We view this as a first step in a program of research that will eventually investigate the identified activities empirically in order to understand whether and under what conditions they support teachers' development of high-quality instructional practices.

We situate this analysis in mathematics and science, because the shift to high-quality teaching in these disciplines requires most teachers to significantly reorganize their current knowledge and practice (National Governor's Association Center for Best Practices [NGACBP] & Common Core State Standards [CCSSO], 2010; NCSS, 2010; NGSS, 2013). While mathematics and science educators have made significant progress in articulating a vision of high-quality instruction, the literature on how content-focused mathematics and science coaches

can support teachers' development of these instructional practices is not as advanced as the work in English language arts and literacy.

Supporting Teachers' Development of High-Quality Instructional Practices

High-Quality Instruction in Mathematics and Science

The mathematics and science education research communities have achieved a broad, empirically grounded consensus on the forms of classroom instruction that support students' attainment of ambitious learning goals (e.g., NGACBP, & CCSSO, 2010; NCTM, 2000; NGSS, 2013). The goals for students' learning in mathematics emphasize the following: conceptual understanding and procedural fluency in a range of mathematical domains; mathematical argumentation to communicate and justify mathematical ideas effectively; and productive dispositions towards mathematics (NCTM, 2014). In science, student learning goals emphasize engaging students in meaningful scientific practices to make sense of the world (NRC, 2012). These goals require students to understand how to represent their claims to others, critique one another's ideas in ways that are civil and productive, and revise their ideas in response to evidence and argument (Windschitl Thompson, Braaten, & Stroupe, 2012).

These goals for student learning are demanding and have implications for instruction. Such instruction requires teachers to build on what students do as they attempt to solve challenging tasks while holding students accountable to learning goals (Kazemi, Franke, & Lampert, 2009; Windschitl et al., 2012). Research in mathematics and science education has delineated a set of teaching practices that support students' achievement of these ambitious learning goals (CCSSM, 2010; NGSS, 2013; NRC, 2012), such as introducing challenging tasks without reducing the level of cognitive demand (Jackson, Garrison, Wilson, Gibbons, & Shahan, 2013; Kang, Windschitl, Stroupe, & Thompson, in press). In mathematics, teachers are expected

to monitor the range of solution strategies that students produce (Horn, 2012) and build on these strategies during whole-class discussions by pressing students to justify their reasoning and make connections between their own and others' solutions (Stein, Smith, Henningsen, & Silver, 2000). In science, teachers are expected to elicit and build upon students' ideas, support students to make progress in their thinking through material activities, and press students for evidence-based explanations (Windschitl et al., 2012).

These practices differ significantly from those used by current mathematics and science teachers, and their development involves a significant reorganization of current practices (Snow-Renner & Lauer, 2005). The required teacher learning encompasses mathematical or science content knowledge (Lo, Grant, & Flowers, 2008), pedagogical knowledge for teaching (Shulman, 1986; Suzuka et al., 2010), knowledge of student reasoning across disciplinary domains (Kazemi & Franke, 2004), and knowledge of curriculum (Ball, Thames, & Phelps, 2008), as well as learning to enact pedagogical routines that give rise to rich learning opportunities for students (Darling-Hammond et al., 2009). One key way to provide sustained support for teachers' learning and development of high-quality practices is through job-embedded professional development.

Instructional Coaching as a Form of Professional Development

Instructional coaches are typically highly accomplished teachers (Neufeld & Roper, 2003; Poglinco, et al., 2003) who are based either in a single school or in the district central office and are charged with supporting instructional and programmatic improvements (Campbell & Malkus, 2011). In this analysis, we are concerned with *content*-focused coaching in which coaches aim to support teachers' development of high-quality instructional practices in a particular discipline. While content-focused coaches have instructional expertise, effective

coaching is not a one-way process in which coaches impart technical skills to teachers. Instead, coaches support teachers in addressing problems of practice by engaging them in activities that focus on key disciplinary ideas, how students learn those ideas, and pedagogical principles to support students' learning (Coburn & Russell, 2008).

Methods for Identifying Potential Productive Coaching Activities

Characteristics of High-Quality Professional Learning

In the first phase of our analysis, we examined the teacher education literature to determine what is known about high-quality professional learning opportunities. Because we are interested in identifying a set of potentially productive coaching activities, we first needed to identify these characteristics to serve as criteria for identifying potentially productive coaching activities (see Figure 1 for a representation of the process of identifying activities). We found an emerging consensus in the teacher education literature regarding characteristics of professional learning (Desimone, 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001; Putnam & Borko, 2000; Wilson & Berne, 1999). We examined seminal reviews of professional development, which were published in peer-reviewed journals and have been cited more than 700 times (based on Google Scholar). Our synthesis of these reviews resulted in five characteristics that represent this emerging consensus.

The first characteristic of high-quality professional learning is that opportunities must be intensive and ongoing. The findings of several studies indicate that teaching practices and student learning are unlikely to improve unless professional development is sustained (Desimone, 2009; Garet et al., 2001), thereby enabling the continued investigation of particular instructional issues and the opportunity to try ideas in the classroom and reflect on the results (Kazemi & Hubbard, 2008; Stein, Silver, & Smith, 1999; Darling-Hammond et al., 2009).

Second, high-quality professional learning activities focus on the problems that teachers encounter in their daily work (Putnam & Borko, 2000; Stein et al., 1999; Wilson & Berne, 1999). Several studies indicate the importance of situating professional development in the context of teaching by using artifacts that originated in the teachers' classrooms, such as student work samples (Cobb, Zhao, & Dean, 2009; Borko et al. 2008; Kazemi & Franke, 2004).

A third and related characteristic is that professional learning orients teachers to focus on student thinking. In both mathematics and science education, researchers call for teachers to use evidence of student thinking to assess progress toward learning disciplinary ideas and to adjust instruction continually in ways that support and extend their learning (NCTM, 2014; NGSS, 2013). Orienting teachers to attend to their students' thinking and reasoning can have strong positive effects on practice, such as the ability to elicit and build on students' thinking (Kazemi & Franke, 2004; Rosebery, Warren, & Tucker-Ray, 2015).

Fourth, high-quality professional learning fosters the development of teacher communities, which provide opportunities to develop a common professional discourse that names critical aspects of instructional practice and student learning (Ball & Cohen, 1999; Cobb, et al., 2009; Darling-Hammond et al., 2009; Desimone, 2009; Garet et al., 2001; Horn & Little, 2010; Kazemi & Hubbard, 2008; Putnam & Borko, 2000; Stein et al., 1999). Ball and Cohen (1999) argue that the development of professional discourse is essential for productive discussions about teaching and learning. Further, professional communities can both support teachers in taking the risks necessary to reorganize their instructional practice, and result in a greater consistency in instruction (Horn & Little, 2010).

A fifth characteristic is that high-quality professional learning provides opportunities to both investigate and enact specific pedagogical routines and practices (Grossman et al., 2009),

what has been termed “active learning” (Desimone, 2009, p. 183). Pedagogies of investigation involve analyzing and critiquing artifacts and representations of classroom practice, such as video-recordings and student work. Pedagogies of enactment involve planning for, rehearsing, and enacting high-leverage practices, thereby supporting teachers in translating their insights while engaging in pedagogies of investigation into practice.

We view these characteristics of high-quality professional learning as essential. We note that these features are applicable to coaches working both with groups of teachers and with individual teachers one-one-one in their classrooms.

Potential Productive Coaching Activities

In the second phase of our analysis, we used these characteristics as criteria for potentially productive coaching activities. Our first step in this phase was to generate a comprehensive list of different types of activities in which coaches might engage either groups or teachers or individual teachers. We did so by examining studies that systematically reviewed the research on professional development, looking for trends or patterns across studies (e.g., Darling-Hammond et al., 2009; Loucks-Horsley & Matsumoto, 1999; Wilson & Berne, 1999). Our review resulted in a list of 15 activities that coaches could use to engage groups of teachers and four activities for engaging individual teachers (see Table 1).

Table 1. Teacher Learning Activities Identified before Analysis

Activities with Groups of Teachers		Activities with Individual Teachers
-Analyzing classroom video*	-Engaging in lesson study*	-Enacting the coaching cycle
-Analyzing test data	-Mapping the standards to the curriculum	-Co-teaching*
-Facilitating book studies*	-Leading one-time workshops about a particular teaching	-Observing and providing feedback*
-Conducting classroom visitations		-Modeling instruction*

-Co-designing instruction*	strategy or disciplinary idea	
-Compiling teacher portfolios	-Rehearsing aspects of instructional practice*	
-Conducting action research	-Writing math tasks/developing curriculum	
-Engaging in the discipline*		
-Examining student work*		
-Journaling about teaching experiences		

*Denotes those activities that satisfied all five essential professional learning characteristics

Our second step was to evaluate the potential of the 19 activities by assessing whether a high-quality enactment of each satisfied the characteristics of high-quality professional learning that we identified (see Figure 2 for a list of all 19 activities and the characteristics each has the potential to meet). For each study we assessed which of the characteristics of high-quality professional learning the activity met. We judged an activity as potentially productive if it satisfied all five essential characteristics we had established based on our review of the literature: ongoing, close to practice, support the development of professional discourse, focus on student thinking, develop a common discourse, and involve either a pedagogy of investigation or enactment. As an illustration, we determined that the activity of examining student work is potentially productive because it can be ongoing, is integrated into teachers’ daily work, focuses on student thinking, can foster a common language for describing students’ reasoning, and is a pedagogy of investigation. In contrast, although mapping state standards to the instructional materials teachers are using can be integrated into daily work and might cultivate a professional discourse, it is unlikely to meet the other characteristics. We judged 10 of the 19 coaching activities to be potentially productive because they satisfied the criteria.

Our final step was to search ERIC, Education Full Text, Google Scholar, and ProQuest Dissertations to identify studies that investigated each of the ten potentially productive activities. Our search terms included variations of the ten activity names (e.g., co-planning for co-designing instruction). This search yielded reports of more than 250 empirical studies conducted using a

wide range of methodologies. We systematically reviewed the reports to determine whether and to what extent there was empirical evidence indicating that each activity supported teachers' learning and documented what was learned. In the case of four of the activities, facilitating a book study, co-designing instruction, rehearsing aspects of practice, and observing and providing feedback, there was insufficient evidence in the current literature of what teachers might learn. We therefore eliminated them from our analysis. We decided not to include the coaching cycles on the grounds of feasibility even though it is frequently discussed in the coaching literature. When the coaching cycle is enacted as intended, coaches typically work intensively with 2-3 teachers at a time for several weeks (Literacy Collaborative Trademark Committee, 2006). However, research to this point indicates that it is rarely fully enacted because coaches and teachers find it difficult to schedule the desired three-step process of planning, observing or modeling, and debriefing (Atteberry & Bryk, 2011; Bean et al., 2010). However, we note that its inclusion might be warranted if the logistical challenges can be resolved, and if there is evidence of its effectiveness at some level of scale.

Four of the remaining six potentially productive activities involve coaches working with groups of teachers: 1) engaging in the discipline, 2) examining student work, 3) analyzing classroom video, and 4) engaging in lesson study. The remaining two activities involve coaches working with individual teachers: 5) co-teaching and 6) modeling instruction.

We next focused on the studies that investigated each of the six activities to clarify both how a high-quality enactment of the activity can support teachers' development of ambitious instructional practices and the facilitator's role in enacting the activity at a high level. While we contend that these activities could be enacted by coaches, we analyze each activity as it is described in the literature. Thus we use the original terms from each study (e.g., "mentor" or

“facilitator”) to denote the professional educator who is supporting either preservice or inservice teachers’ learning. In the next section, we report the findings of this review for each of the six types of activities.

Findings

Activities Conducted With Groups of Teachers

Engaging in the Discipline. Engaging teachers in mathematical and scientific inquiry has featured prominently the teacher education literature for over two decades. Substantial evidence indicates that teachers’ ability to make disciplinary ideas accessible and learnable by all students depends partly on their own *specialized* disciplinary knowledge, which comprises the content knowledge and pedagogical skills required for effective teaching (Ball, et al., 2008; Suzuka et al., 2010). In mathematics, Hill, Rowen, and Ball (2005) found that the relationship between teachers’ mathematical knowledge for teaching and their students’ mathematics achievement is significant. One avenue for supporting the development of teachers’ disciplinary understandings and influencing how those understandings affect instruction is guided investigations of disciplinary content.

The aim of disciplinary investigations is to challenge teachers’ own specialized disciplinary knowledge and their view of disciplinary norms as they engage in rich explorations of mathematics or science. Analyses of these investigations indicate that facilitators placed teachers in the role of student, supporting them to develop a stance of inquiry and cultivate a disposition that examines ideas. However, facilitators supported teachers to engage with the content in deeper ways than would be required if the goal was to solve tasks by developing a single strategy. As a consequence, facilitators supported teachers in thinking through how they might use tasks in their classrooms by pressing them to anticipate students’ correct and incorrect

strategies and consider how they might respond to those strategies (Borko et al., 2011).

Following is a synthesis of findings from two major professional development initiatives, one in mathematics and one in science.

In the first initiative, Schifter and Fostnot (1993) and Schifter (1998) examined thirty-six elementary and middle grades teachers' participation in professional development sessions that spanned four years, including summer institutes, biweekly seminars, and biweekly classroom coaching. A major component of the sessions included teachers doing mathematics. Schifter (1998) explains that teachers "experience mathematics, often for the first time, as an activity of construction, rather than as a finished body of results to be accepted, accumulated, and reproduced" (p. 65). In one analysis, Schifter (1998) focused on two cases in which changes in the teachers' beliefs about mathematics led them to re-organize their classrooms around whole class inquiry into students' mathematical ideas.

A second initiative was led by Borko and colleagues (2005) aimed to support the development of teachers' understanding of key algebraic concepts and their knowledge about teaching algebra in an inquiry-oriented setting. Sixteen elementary and middle-grade teachers attended a two-week institute and ongoing monthly meetings. The researchers' comparison of pre- and post-assessments indicated that doing mathematics with a skilled facilitator resulted in modest gains in the participating teachers' mathematical knowledge for teaching. (See also, Ball et al., 2008; Elliott et al., 2009; Lo et al., 2008; Suzuka et al., 2010).

In science education, Rosebery and colleagues (2015) supported teachers' engagement with scientific phenomena as learners so they could experience the meanings, perspectives, and stances that arise in science learning and teaching. Twenty-eight elementary and middle-school early career teachers engaged in 30 hours of professional learning in the domain of plant life

cycles as a foundation for learning to focus on students' scientific interpretations and come to value their diverse sense-making. The professional development also emphasized interpreting, critiquing, and creating representations of scientific phenomena. The researchers found that, as a result of engaging in scientific inquiry, with a focus on student thinking, teachers understood the science better themselves, more readily considered the students' perspectives, and had a greater appreciation for the complexity of students' thinking.

Several recent studies have investigated efforts to assist facilitators in supporting teachers' learning as they engage in mathematics. Borko and colleagues (2011) and Elliott and colleagues (2009) sought to clarify what effective facilitators need to know and be able to do and concluded that they delineate mathematically worthwhile goals for teachers' learning and select tasks that are relevant for particular groups of teachers. In both studies, facilitators first supported teachers' engagement with the selected tasks and then elicited teachers' solutions and pressed them to question one another. Elliott and colleagues (2009) also reported that effective facilitators led productive discussions by intentionally *slowing down* conversations to focus explicitly on mathematical ideas, pressing teachers for explanations and justifications, and stepping back to make some of their practices as facilitators explicit.

The studies reviewed above indicate the potential value in coaches engaging teachers in disciplinary inquiry as it can deepen their specialized disciplinary knowledge. Additional research is needed to clarify how accomplished coaches leverage their access to teachers' classroom practices when they plan disciplinary inquiries with groups of teachers. Further research is also needed to understand how coaches can make explicit connections between teachers' engagement in disciplinary inquiry and their selection and enactment of rigorous

instructional tasks with their students. In other words, how can coaches build on this activity to support teachers' development of high-quality instructional practices?

Examining Student Work. Research conducted over the past 20 years indicates that teachers' understanding of students' thinking is integral to effective instruction (Carpenter, Fennema, & Franke, 1996). Examining student work from teachers' own classrooms has been proposed as a primary activity for learning about student thinking (Carpenter et al., 1996; Cobb et al., 2009; Little, Gearhart, Curry & Kafka, 2003). Across the studies reviewed below, researchers conjectured that through examining student work, teachers would have opportunities to learn how students' understanding of particular disciplinary ideas develop. The intent of professional learning activities used in these studies was to support teachers in coming to appreciate the range of their students' ideas and eventually, to build on those ideas during instruction. Further, researchers took changes in teachers' discourse and in group norms during professional development sessions as evidence of teachers' learning.

In a series of studies Kazemi & Franke (2004) and Jacobs, Franke, Carpenter, Levi, and Battey (2007) supported a group of elementary teachers' learning about their students' mathematical reasoning in monthly meetings to examine their students' mathematical work. They used common problems in their classrooms and were supported to infer their students' mathematical thinking using principles and terminology from *Cognitively Guided Instruction* (Carpenter, Fennema, Franke, Levi, & Empson, 1999). As the meetings progressed, teachers increasingly attended to the details of their students' thinking, generated strategies for eliciting student thinking, and developed possible trajectories for instruction and student learning. The researchers argued that these changes could support the development of instructional practices that focus on student thinking but did not assess whether there were improvements in practices.

Windschitl and colleagues (2011). conducted a series of studies with secondary science teachers in which they led monthly meetings in that supported teachers to use a protocol for engaging in a cycle of inquiry, reflection, and action that included collecting and analyzing samples of their students' written work. Windschitl and colleagues (2011) and Thompson and colleagues (2009) found that the participating teachers increasingly framed student work as evidence of student understanding and as a resource for instructional improvement. Similarly, Gearhart and colleagues (2006) found evidence that analyzing student work resulted in science teachers selecting tasks that were better aligned with their goals for student learning and built on students' thinking. Furthermore, there was evidence in this and the other studies that teachers began to develop both a common language for describing student understanding and routines for eliciting student thinking.

Most of the studies reported here emphasize the role of the facilitator in making the study of student work productive. In this regard, Little and colleagues (2003) examined three professional development programs that used student work and identified a number of facilitator practices that shaped the conversations. These practices included purposefully selecting student work samples in light of the facilitator's goals for teachers' learning, supporting teachers to situate the focal lesson within the encompassing instructional sequence, and orienting teachers to analyze students' thinking rather than merely evaluate their solutions (Cobb et al., 2009; Little et al., 2003). This orientation involved pressing teachers to consider what students did to solve the problem, why they solved it in particular ways, and what their strategies revealed about their understanding of key ideas. There was also evidence across the studies that effective facilitation involved supporting teachers to elicit students' thinking and to determine which student

strategies to highlight in whole class discussions in light of their goals for students' learning (Gearhart et al., 2006; Kazemi & Franke, 2004; Thompson et al., 2009).

The studies reviewed here suggest the potential of coaches engaging teachers in analyzing student work. A high-quality enactment of this activity can support teachers in developing a common language for describing students' reasoning, including naming different types of student reasoning and the strategies they use. Future research might investigate how coaches can support teachers across grade levels to develop common formative assessment tasks that elicit students' thinking. Research might also clarify how coaches can support a group of teachers in examining the resulting data to link their insights about their students reasoning to their prior instruction. Future research can also clarify how coaches can support teachers in building on their insights about students' current ideas when they plan for upcoming instruction, including how they identify instructional goals. Finally, additional research is needed to understand how coaches can use this activity to support teachers' in eliciting and responding to students' thinking more effectively.

Analyzing Classroom Video. The use of classroom videos as a representation of practice has become increasingly common in professional development and teacher education in recent years (Borko, Jacobs, Eiteljorg, & Pittman, 2008; van Es and Sherin, 2010; Zhang, Lundeberg, Koehler & Eberhardt, 2011). Across the studies reviewed below, researchers conjectured that video can support teachers' collective analysis of pedagogical strategies (Brophy, 2004) and their development of an interpretive perspective that relates instruction to students' thinking and learning opportunities.

Sherin and her colleagues (Sherin & Han, 2004; Sherin, 2004) conducted a series of studies that examined the "Video Club" professional development model in which university

mathematics educators supported a group of elementary teachers from an urban school as they viewed and discussed excerpts of videos from their classrooms in 10 sessions over the course of a year. During the sessions, facilitators supported teachers in using evidence from video segments to support their claims about the students' mathematical understandings. The participating teachers' analyses shifted from an initial focus on classroom management to student mathematical thinking, with increased discussion of the importance of attending to student ideas during instruction (see also Borko, 2004; Borko et al., 2005). van Es and Sherin (2010) examined the teachers' classroom practices and found an increase in the extent to which teachers supported students in making their thinking public, elicited multiple strategies from students, and probed students' underlying understandings.

Zhang and colleagues (2011) researched a video-based professional development model for science teachers across grades K-12 that included a seven-day summer workshop and a year-long teacher research project. This study complements Sherin's work by examining the affordances and constraints of supporting teachers' analysis of three types of classroom video: commercially published video, teachers' own video, and peers' video. Teachers also developed a research plan to study their own practice in which they had autonomy in outlining a teaching dilemma, hypothesis, and data collection plan. Teachers reported that the video viewing activities allowed them to see multiple models of teaching, reflect on their own teaching by watching their own video multiple times, and address the difficulties they encountered in implementing new instructional practices. In a case study analysis of participating teachers, the researchers found that video supported the teacher to learn and gain images of inquiry-based teaching strategies (e.g., how to probe for student thinking) and identify areas they wanted to improve in their own teaching (e.g., "How to assess students' retention of the big ideas?...

During inquiry instruction, what amount of instruction/explanation must or should come from the teacher?" p. 461). However, Zhang and colleagues did not examine whether there were improvements in teachers' practices.

Although the findings of these studies are encouraging, it is also clear that teachers do not necessarily gain new insights about practice merely from watching classroom videos (Brophy, 2004). It appears essential that facilitators first establish a clear purpose for viewing a video that is based on specific goals for teachers' learning (Brophy, 2004; Borko et al., 2008; van Es, Tunney, Goldsmith, & Seago, 2014). In this regard, Borko and colleagues. (2008) found that effective facilitators selected video clips and identified foci that would stimulate discussion of key issues. Effective facilitation also clarified the classroom context when they introduce a clip, by asking participants to clarify key contextual features, including (a) the instructional goals for and big disciplinary ideas of the lesson, (b) student characteristics, and (c) the place of the lesson in a larger instructional sequence. Additionally, researchers identified a series of facilitator moves that supported teachers to conduct a substantive analysis of teaching (Borko et al., 2008; van Es et al., 2014). In addition, effective facilitators posed structured discussion questions and routinely pressed the group to take a more critical look at the videoed teacher's practices (e.g., "How did the teacher's questions help him to understand how Kaitlin derived her expression?" (p. 428). There is evidence that this press on relations between instructional practice and student thinking supports teachers in explaining students' contributions (Sherin & Han, 2004), inferring possible reasons for the videoed teacher's instructional decisions (Sherin, 2004) and formulating questions that uncover student thinking (Borko et al., 2008).

The findings of the studies reviewed here indicate the value of coaches engaging groups of teachers in examining videos of their instruction. The studies suggest that coaches' skilled

enactment of this type of activity can support teachers in developing a common language for talking about student mathematical thinking and in attending to their students' thinking during instruction. In this regard, van Es and Sherin's (2010) findings suggest that teachers might increasingly elicit students' explanations and probe students' underlying understandings. Research is needed to understand how accomplished coaches capitalize on their access to teachers' classrooms and current instructional practices when selecting video episodes to use with teachers and to establish purposes for their use. Further, research is needed to understand how coaches can build on the analysis of videos when they subsequently work with teachers in their classrooms. How does analyzing video support coaches to influence what teachers notice as they enact a lesson and to refine their instruction?

Engaging in Lesson Study. In the past decade, considerable progress has been made in grounding professional development in teachers' classroom practice (Morris & Hiebert, 2011). Lesson study and variations thereof ("Studio Days" or "Learning Labs") have been influential in this regard. Lesson study typically involves a small group of teachers working together for several months, often with an expert (e.g., a university facilitator or school-based coach) to improve a particular lesson (Morris & Hiebert, 2011). In the lesson study cycle, teachers collaborate to develop a detailed lesson plan, then one teacher teaches the lesson while others observe, and finally the group analyzes the observed lesson in order to further improve the lesson plan (Hart, Alston, & Murata 2011; Lewis, Perry, & Murata, 2006). This cycle is then repeated, with one of the teachers implementing the revised lesson plan. The process of developing the initial lesson plan involves specifying learning goals for the lesson, reviewing relevant literature, and discussing instructional approaches for helping students attain the learning goals (Hart et al., 2011; Lewis et al., 2006; Morris & Hiebert, 2011).

Similar to lesson study, Studio Days and Lesson Lab both involve a cycle collectively planning for, enacting, and debriefing instruction. However, Studio Days places less emphasis on refining a lesson and instead, prioritizes making teaching public as a way to refine evidence-based teaching routines (Teachers Development Group, 2010). In the Lesson Lab variation, teachers learn to enact classroom routines of relatively short duration (e.g., a number talk) rather than an entire lesson, and the group of teachers' co-enact activities rather than observing a demonstrated lesson (Gibbons, in press; Kazemi, Hintz, Gibbons, Lewis, & Lomax, 2014). Across the studies reviewed below, researchers conjectured that lesson study and variations thereof, would support teachers' development of particular aspects of high-quality instructional practices. For example, in science, the aim of multiple Studio Days was to develop teachers' ability to press for evidence-based explanations (Thompson, Barchenger, & Haganeah, 2014). In mathematics, for example, facilitators of multiple Studio Days intended to support teachers' ability to "understand and identify student talk that reflect the practices of justification" (Lesseig, 2014, p. 6).

Lesson study and, to a lesser extent, the two variations have been widely implemented in the United States. We found several hundred studies that examined lesson study. Due to limited space, we report only the findings of some of the most frequently cited studies. Lesson study has been shown to improve student achievement in elementary mathematics on end of the year courses (Gersten et al., 2014). There is evidence that teachers' participation in lesson study can enhance their knowledge of content, pedagogy, and students' thinking (e.g., support teachers in understanding how children think about the equal sharing problems and in selecting subsequent tasks to further their thinking) (Fernandez, 2002). There is also evidence that lesson study can strengthen professional community through the development of collaborative norms, mutual

accountability, and shared frameworks for enacting and analyzing practice (e.g., common lesson plans or instructional tasks) (Lesseig, 2014).

Taken together, these findings make it clear that an accomplished facilitator is essential. However, only a few studies have investigated the role of the facilitator in supporting teacher learning across the lesson study cycle (Gallucci, Van Lare, Yoon, & Boatright, 2010; Lesseig, 2014). Lesseig's (2014) findings indicate the importance of facilitators supporting teachers' learning through guiding the establishment of group norms, as well as summarizing, rephrasing, and recording ideas generated by the group, and by pressing teachers to provide either evidence or a rationale for their decisions. There is also evidence that when facilitators pushed teachers to think more deeply about the disciplinary goals of the lesson and the trajectory of students' learning, teachers subsequently designed more conceptually oriented lessons that involved more challenging instructional tasks. Finally, it is important for facilitators to focus teachers' observations and subsequent debriefing conversations on student thinking (Lewis, 2006).

The studies examined provide evidence that lesson study is a potentially productive coaching activity that enables coaches and teachers to plan lessons and analyze their enactment together. It provides opportunities for coaches to help teachers deepen their knowledge of content, orient teachers to focus on their students' thinking, and support them in enacting high-quality lessons. Additional research is needed to understand how accomplished coaches determine the aspects of practice to work on during lesson study and how they help to establish norms that support learning and improve practice. We also need to understand how coaches can determine which tools can assist them in facilitating lesson study and which coaching routines can be established in lesson study that can enable coaches to continue to support teachers one-on-one in their classrooms.

Activities Conducted One-on-One with Teachers in Their Classrooms

The activities we have discussed thus far involve coaches working with groups of teachers. Another group of studies that we examined investigated the provision of support for teachers in their classrooms, as a form of ongoing follow-up support. One-on-one coaching activities that appear to be potentially productive include: (a) co-teaching and (b) modeling. Although these activities appear frequently in the coaching literature (Bean et al., 2010; Neufeld & Roper, 2003; Poglinco et al., 2003), they are rarely justified in terms of their potential to support teachers' development of ambitious instructional practices.

Co-teaching. Researchers who have examined how people develop complex professional practices have emphasized the importance of participating in a practice with a more knowledgeable other (Lave & Wenger, 1991). Tharp and Gallimore (1988) argued that co-participation supports the learner in ways that language alone cannot: "The development of common understanding of purposes and meanings of the activity, [and] the joint engagement in cognitive strategies and problem solving are all aspects of interaction that influence each participant" (p. 89). Through co-participation, the more knowledgeable other works alongside a less accomplished teacher in authentic situations, and they both influence classroom events and then negotiate interpretations of these events (Roth & McRobbie, 1999).

Very few studies have investigated the conditions under which co-teaching is productive in supporting practicing K-12 teachers' learning. However, a number of studies have focused on co-teaching as a support in either teacher education or teacher induction (Eick et al., 2003; Roth & McRobbie, 1999; Scantlebury, Gallo-Fox, & Wassell, 2008; Tobin & Roth, 2006). Across the studies reviewed below, researchers conjectured that planning and teaching with the mentor

teacher supports student teachers to reflect more deeply about their practice, identify important problems of practice, and internalize specific high-leverage practices such as orchestrating classroom discussions (Eick, Ware, & Williams, 2003; Roth & McRobbie, 1999).

Eick and colleagues (2003) examined how co-teaching could support student teachers to reflect on instruction by examining ten secondary science student teachers co-teaching experiences over an eight-week period). The student teachers were paired with experienced mentor teachers for two consecutive class periods. During the first period, student teachers observed and assisted the mentor teacher by working with small groups or individual students. During the second period, the student teachers taught the same lesson, and the mentor teachers provided assistance. Most of the student teachers reported that they felt supported when they attempted to implement specific instructional practices (e.g., how to phrase a question or represent a students' idea) and manage the classroom. The researchers did not assess changes in the student teachers' knowledge or practice. They concluded, however, that the activity of co-teaching allowed student teachers to both learn in the context of practice and engage in critical reflection about inquiry-based teaching.

Eick and colleagues' (2003) also examined how the mentors supported the student teachers and found that assistance during instruction included logistical support (e.g., assisting with the setting up materials) and ongoing verbal interjections throughout the lesson (e.g., asking students questions to help the student teacher assess students' understanding). The findings of several other studies indicate the importance of focusing post co-teaching dialogues on aspects of practice that impact student learning and on generating solutions to problems of practice (e.g., when planning a science lesson, considering the feasibility of doing an experiment with students) (Scantlebury, et al., 2008). Tobin and Roth (2006) also suggest that mentors should ground

debriefing conversations with teachers in a specific lesson, and recommend focusing both how the lesson could be improved and what should take place in subsequent lessons.

The studies reviewed here provide evidence that coaches might be able to support teachers in improving how they plan instruction and enact particular practices by co-teaching with them. Future studies should seek to understand how accomplished coaches develop relationships with teachers to allow for engagement in co-teaching. Also important to consider are: which aspects of practice are most open to refinement during co-teaching, when is it productive for coaches and teachers to confer about aspects of practice, and what types of questions and feedback are useful to teachers during subsequent debriefing discussions.

Modeling. While co-teaching is a potentially important means of support, there is evidence that observing a more accomplished colleague enact particular practices can also be productive. Modeling typically involves an accomplished teacher intentionally demonstrating certain teaching practices with the aim of providing student teachers with images of the possible (Tharp & Gallimore, 1988). There is evidence that modeling can support teachers in developing an image of accomplished enactment of those practices (Feiman-Nemser, 2001; West & Cameron, 2013) and might therefore be appropriate as a starting point for teachers' development of particular instructional practices.

Several studies have examined how teacher educators model "new visions learning" to preservice teachers (e.g., Bronkhorst, Meijer, Koster, & Vermunt, 2011; Lundenberg, Korthagen, & Swennen, 2007). Feiman-Nemser (2001) examined how an accomplished teacher's mentoring practices, which included modeling, supported eight beginning elementary teachers in an two-year induction program. Feiman-Nemser conducted interviews with the beginning teachers and the mentor teacher and observed beginning teachers' practices in order to understand the

mentor's practices. The mentor described modeling as a way to give a "living example" of teaching. Through his modeling, he hoped that the student teachers would begin to identify characteristics of good teaching (e.g., responding to students' ideas). To accomplish this, he often paused during the lesson to highlight key aspects of his practice and to explain what he was doing and why. After the lesson, the mentor asked the beginning teachers to interpret what they saw. Unfortunately, Feiman-Nemser did not investigate what the beginning teachers learned from observing the mentor teacher.

There is some indication that modeling might be a useful starting point for coaches as it can support teachers in developing an image of what is possible in mathematics or science instruction. More research is needed to understand how accomplished coaches support teachers to notice particular aspects of instruction when they engage in modeling. Future studies should also seek to understand how modeling instruction in teachers' classrooms can support them to reconsider what their students know and are capable of doing. It is also important to understand the types of tools that accomplished coaches use during debriefing conversations with the teachers after lessons.

Discussion

In this article, we set out to identify potentially productive activities that coaches can enact with teachers to support their development of high-quality instructional practices. Because the current coaching research literature typically fails to justify coaching activities in terms of teacher learning opportunities, we drew on the teacher education literature to identify activities that have the potential to support teachers' development. We identified four potentially productive activities in which coaches might engage groups of teachers: 1) engaging in the discipline, 2) examining student work, 3) analyzing classroom video, and 4) engaging in lesson

study. In addition, we identified two potentially productive activities that involve coaches working with individual teachers: 5) co-teaching and 6) modeling instruction. For each activity, we described what teachers might learn as a result of engaging in a high-quality enactment, discussed the implications for coaching, and examined what a high-quality enactment might entail. We regard this analysis as a first step in specifying a technical core of instructional coaching that can provide guidance to coaches and inform the design of coaching initiatives and endorsement programs.

In considering future research, we first note that the majority of the studies that we reviewed investigated teachers' learning as they engage in group activities. In contrast, the research on activities conducted one-on-one with teachers in their classrooms is quite thin. Research is therefore needed to better understand how accomplished coaches engage in modeling and co-teaching with teachers. For example, additional studies are needed to understand which aspects of instructional practice are most fruitful for coaches to work on with teachers in their classrooms and how accomplished coaches make decisions about the aspects of practice on which to focus. The types of feedback that are productive in supporting teachers' learning are also largely understudied. Studies are therefore needed that focus explicitly on the relation between types of feedback coaches give to teachers, the extent to which the feedback is tailored to teachers' current practices, and any subsequent improvements in their instructional practices. Finally, more studies are required to understand how coaches can sequence different types of activities to create a coherent set of supports for teachers that take account of teachers' current instructional practices.

We were able to make some progress in teasing out aspects of effective enactments of the six practices and identified three cross-cutting facets of facilitator practice that are relevant to

coaches' enactment of the activities. The first facet concerns the importance of formulating explicit goals for what teachers might learn as a result of engaging in a particular activity. The second facet, which is specific to activities enacted with groups of teachers, involves establishing norms that orient the group towards the improvement of instructional practice. The third facet involves selecting tools, including artifacts from classrooms, that enhance the enactment of particular activities.

However, it is also important note that only a small proportion of the studies that we reviewed systematically examined facilitators' actions (e.g., Borko et al., 2011; Elliott et al., 2009; Lesseig, 2014; van Es et al., 2014). Further research is therefore needed to delineate additional aspects of accomplished enactments. With regard to the first facilitator facet of formulating explicit goals for teachers' learning, for example, we need to better understand both how accomplished coaches identify worthwhile goals for specific teachers' learning in group and one-on-one settings, and why they delineate more productive goals than less accomplished coaches. With regard to the facet of establishing productive group norms, it would be helpful to know how accomplished coaches negotiate norms for collective work with teachers who are frequently also their colleagues. With regard to the third facet of selecting appropriate tools, we need to know more about both how and why accomplished coaches make these selections and about how they use the tools to support teachers' learning.

In identifying potentially productive activities, we noted several activities that met the criteria for high-quality professional learning, but for which there is insufficient evidence about what teachers might learn in the current literature. These activities include facilitating a book study, co-designing instruction, rehearsing aspects of practice, and observing and providing feedback. More research is therefore needed on these activities to understand what teachers learn

from engaging in them. In addition, we noted that the coaching cycle satisfied the criteria for high-quality professional learning, but that current research indicates that it is rarely fully enacted because coaches and teachers find it difficult to schedule the three-step process of planning, observing or modeling, and debriefing. There is therefore a need to for research that investigates both whether and how the coaching cycle can be implemented as intended, and what teachers can learn from engaging in a high-quality enactment of the activity.

As a final observation, the analytic approach that we used is relevant to researchers who seek to investigate the design and enactment of coaching activities and of professional learning activities more generally. As we have illustrated, this analytic approach involves delineating the goals for teachers' learning, documenting the rationale for the activities in which teachers engaged, and examining evidence of the extent to which learning goals were attained. Because the approach foregrounds teacher learning opportunities, the findings offer empirically grounded specifications of the substance of coaches' work with teachers. The findings are therefore relevant to school and district leaders and teacher educators. For example, they can guide decisions about how coaches might focus their efforts to support instructional improvement, thereby enabling better definitions of coaches' work. In addition, the clarification of what effective enactments of potentially productive activities look like serves to delineate goals for coaches' learning. In this regard, our findings have informed the design of mathematics specialists degree programs for future coaches and can also inform the work of district mathematics specialists and others charged with supporting coaches in working more productively with teachers.

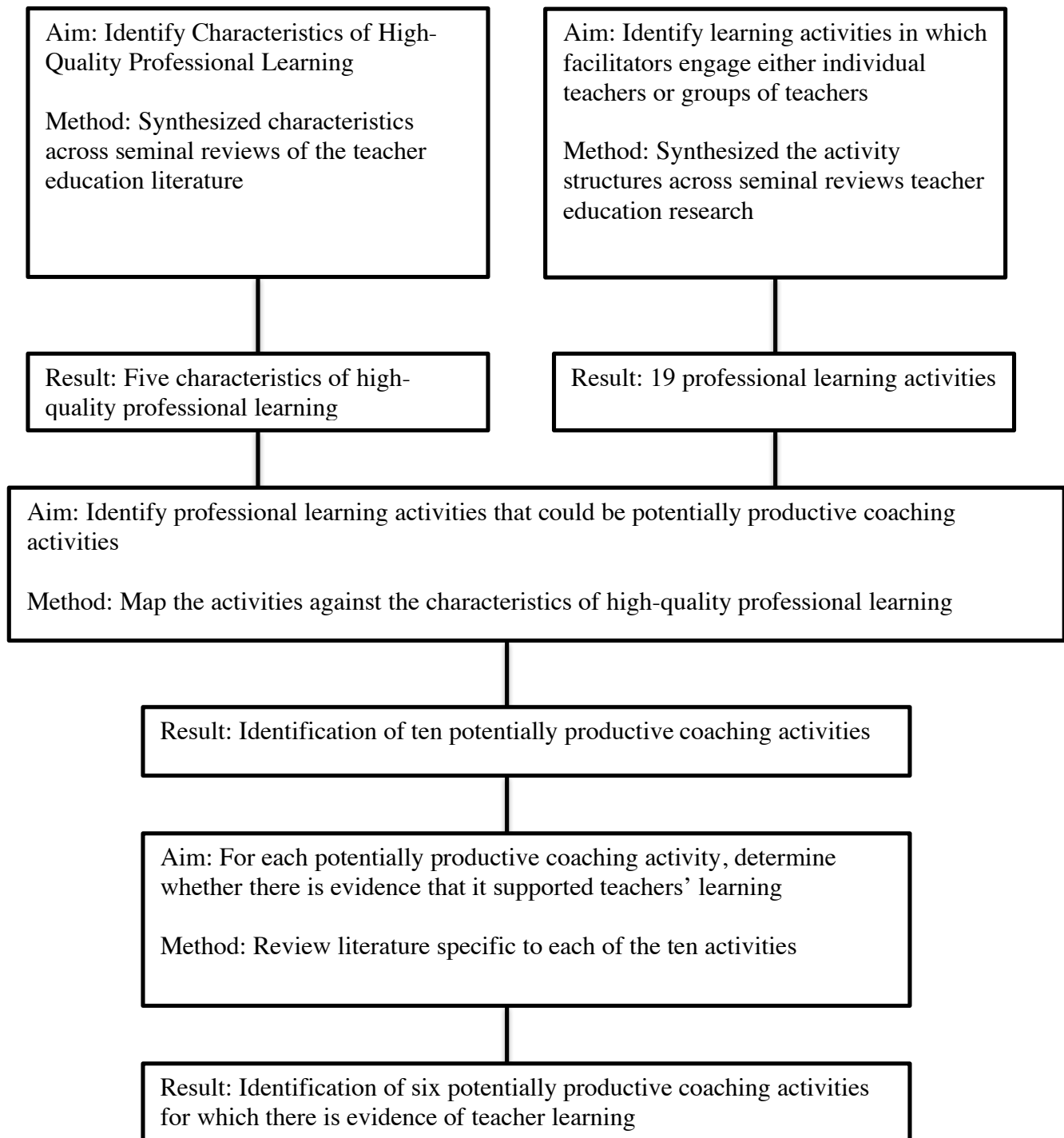


Figure 1. Approach to Identifying Potentially Productive Coaching Activities

Possible Activities with Groups of Teachers					
	Intensive and Ongoing	Integrated into Problems of Practice	Pedagogies of Investigation or Enactment	Cultivates Common Language	Focus on Student Thinking
Analyzing classroom video <i>Discussing excerpts of classroom videos (Loucks-Horsley & Matsumoto, 1999)</i>	X	X	X	X	X
Analyzing test data <i>Analyzing test data, typically to identify which students need remediation or what teachers should reteach (Darling-Hammond, et al., 2009)</i>		X			
Facilitating book study* <i>Examining narratives and case discussions (Loucks-Horsley & Matsumoto, 1999)</i>	X	X	X	X	X
Conducting classroom visitation <i>Observing other teachers' instruction (Darling-Hammond, et al., 2009)</i>		X	X	X	X
Co-designing instruction* <i>Collectively identify instructional tasks and develop assessments (Darling-Hammond, et al., 2009)</i>	X	X	X	X	X
Compiling teacher portfolios <i>Collecting artifacts and reflections that document a teacher's professional practice (Wilson & Berne, 1999)</i>		X			
Conducting action research <i>Documenting and analyzing teaching experiences (Wilson & Berne, 1999)</i>		X	X		X
Engaging in the discipline <i>Engaging in disciplinary content with other teachers (Loucks-Horsley & Matsumoto, 1999)</i>	X	X	X	X	X
Examining student work <i>Examining students' responses to mathematical tasks (Loucks-Horsley & Matsumoto, 1999)</i>	X	X	X	X	X
Journaling about experiences <i>Recording observations and reflections (Wilson & Berne, 1999)</i>	X	X			X
Engaging in lesson study <i>Collaboratively planning, teaching, observing and critiquing a small number of lessons (Darling-Hammond, et al., 2009)</i>	X	X	X	X	X
Mapping the standards to the curriculum <i>Examining standards to identify which mathematics to teach (Loucks-Horsley & Matsumoto, 1999)</i>		X		X	
Leading one-time workshops <i>Leading workshops aimed at implementing new curriculum materials or teaching strategies (Loucks-Horsley & Matsumoto, 1999)</i>				X	
Rehearsing aspects of instructional practice* <i>Trying out new instructional practices, without students present, while receiving feedback (Kazemi et al., 2009)</i>	X	X	X	X	X
Writing math tasks/curriculum development <i>Adapting or creating curriculum materials (Loucks-Horsley & Matsumoto, 1999)</i>		X		X	

Possible Activities with Individual Teachers					
	Intensive and Ongoing	Integrated into Problems of Practice	Pedagogies of Investigation and Enactment	Cultivates Common Language	Focus on Student Thinking
Coaching cycle <i>Engaging teachers in a preobservation discussion, observation, and postobservation discussion (Bean et al., 2010)</i>		X	X	X	X
Co-teaching <i>Working collaboratively with coaches to co-construct and co-teach lessons together (Poglinco et al., 2003)</i>	X	X	X	X	X
Debriefing challenges of implementation* <i>Being observed by experts in order to receive critical feedback (Putnam & Borko, 2001)</i>	X	X	X	X	X
Observing instruction (Modeling) <i>Observing coach and engaging in discussions about goals, tasks, teaching strategies, and student learning (Putnam & Borko, 2001)</i>	X	X	X	X	X

*Denotes those activities that met all 5 characteristics of effective professional development; however, the description in the research of what teachers had opportunities to learn from these activities was insufficient to include in final analysis. The activities in **bold** have met all of the characteristics and are discussed in this analysis.

Figure 2. Potential Coaching Activities

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