Coaching Mathematics Teachers In-Person and Online: A Content-Focused Coaching Model

A White Paper from the Center for Professional Development and Education Reform

Cynthia Callard, University of Rochester

Jennifer Kruger, University of Rochester

Ryan Gillespie, University of Idaho

Eugenie Foster, University of Rochester

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Background

The Center for Professional Development and Education Reform at the University of Rochester (Rochester, New York) has collaborated with organizations and institutions in the region and across the country for over 20 years to connect research to practice through outreach. Interconnected to and nested within the University's graduate school of education, the Center is uniquely poised to bring cutting-edge resources and ideas to the field through leadership development, program evaluation, and professional learning. Professional coaching is one of the primary activities in which the Center engages to support the growth and learning of K-12 educators.

As part of the work of the Mathematics Education Outreach Team in the Center for Professional Development and Education Reform, we have engaged in content-focused coaching with hundreds of K-12 teachers seeking to deepen their understanding of mathematics and the teaching and learning of mathematics. Content-focused coaching is a job-embedded form of professional learning that has shown to support teachers in implementing ambitious instructional practices and strengthen both teacher and student content knowledge (e.g., Campbell & Malkus, 2011; Ellington et al., 2017). Building on over 15 years of in-person content-focused coaching experience, we recently designed, implemented, and researched a fully online content-focused coaching model that provided mathematics teachers across the country with new and innovative opportunities for professional learning.

This paper shares our work with in-person and online content-focused coaching. We begin with a brief overview of coaching, then provide a description of our in-person content-focused coaching model grounded in the work of Lucy West, Fritz Staub, Antonia Cameron, and the Institute for Learning at the University of Pittsburgh. This is followed by a description of our fully online content-focused coaching model. We discuss our guiding principle and how it has informed our design choices and then explain the affordances online content-focused coaching provides.

What is Coaching?

Over the past two decades, coaching has become widespread in the United States to improve learning opportunities for teachers (Campbell & Griffin, 2017; Desimone & Pak, 2017), especially in mathematics and literacy education (Kraft et al., 2018). The rise in coaching stems from four developments. First, educational policies have dramatically increased expectations for improved learning outcomes for *all* students, creating additional demands on teachers (e.g., Common Core State Standards Initiative, 2010; No Child Left Behind Act, 2001). Second, educational researchers have shown strong links between teacher quality and student learning outcomes (Darling-Hammond, 2000). Third, research has highlighted the need for professional learning activities that are ongoing, collaborative, and embedded in daily practice (Borko et al., 2011; Desimone, 2009). Fourth, research has offered theoretical and empirical evidence that coaching can improve teacher practices and student achievement (Campbell & Malkus, 2011; Desimone & Pak, 2017).

There are many types of coaching, including cognitive coaching, instructional coaching, and content-focused coaching. Each approaches the work between coach and teacher differently, reflecting the model's respective goals and purposes. Cognitive coaching aims to assist teachers in increasing their range of instructional practices by reflecting on the rationale behind their current practice, leading to a conscious exploration of new possibilities within instruction (Costa & Garmston, 2016). Instructional coaching focuses on developing a partnership to improve instruction by emphasizing four main aspects of teaching: classroom management, teacher content knowledge, powerful instructional practices, and formative assessment (Knight, 2007). Content-focused coaching aims to influence teachers' instructional practices and student learning by focusing on the content taught and the evidence of student understanding of that content (e.g., Gibbons & Cobb, 2016; West & Staub, 2003). Unlike other coaching models, content-focused coaching places the content of a lesson at the center of coaching conversations (Bickel et al., 2017; West & Cameron, 2013).

Our Project

We designed, implemented, and studied our fully online content-focused coaching model as part of a joint venture between the University of Rochester and the University of Idaho, with funding from the National Science Foundation (grant #1620911). The model was originally designed for teachers in rural areas because they often lack access to professional development in terms of availability and quality (Maher & Prescott, 2017; Robinson, 2008). Between 2015 and 2020, we worked with 19 teachers in Grades 4-8 in rural school districts located in upstate New York and Idaho on a fully online professional learning opportunity in which content-focused coaching was one component. Teachers participated in the project for two years, during which they engaged in two to three coaching cycles per year with the same coach. A total of 46 coaching cycles took place in the project over five years.

Overview of Content-Focused Coaching and Our Guiding Principle

Content-focused coaching seeks to engage teachers in activities that focus on key concepts in a particular discipline, how students learn those concepts, and the pedagogical knowledge that is key to the specific discipline (Gibbons & Cobb, 2016). The primary goals of content-focused coaching are to (1) increase the teacher's content knowledge in a specific subject area and (2) build the teacher's knowledge of effective instructional practices related to that subject area, referred to as pedagogical content knowledge (Ball et al., 2008; Cobb & Jackson, 2011; Shulman, 1987). Content-focused coaching supports attempts to implement pedagogical approaches that make student thinking visible in order to better assess understanding. These pedagogical approaches connect content knowledge to pedagogical content knowledge because they require that teachers recognize how content "comes to life in the minds of learners" (West & Cameron, 2013, p. 4). Content-focused coaching, unlike other models of coaching, places the content of a lesson at the center of coaching conversations and fosters an authentic partnership in which the teacher and coach co-construct and reflect on lessons and share accountability for student learning (e.g., Bickel et al., 2017; West & Cameron, 2013; West & Staub, 2003).

Researchers have found that content-focused coaching can positively affect teachers' instructional practices and student achievement in literacy (Matsumura et al., 2012) and mathematics (Campbell & Malkus, 2011; Neuberger, 2012). Bickel et al. (2017) noted that teachers engaging in content-focused coaching cycles "made significant gains in their capacity to use high-level tasks that ask students to think and reason about math" (p. 7).

Building from prior research and literature on coaching, the guiding principle for the design and implementation of our content-focused coaching model is:

If coaches maintain an intentional focus on specific, high-leverage teaching practices during all coaching conversations and activities, they can reliably achieve positive outcomes related to teacher growth and student learning.

These high-leverage teaching practices include:

1. Focusing on key mathematical concepts and how students engage with those concepts (e.g., Bickel et al., 2017; West & Cameron, 2013; West & Staub, 2003);

2. Selecting and implementing high cognitive demand tasks aligned with clear mathematical goals for understanding (e.g., Gibbons & Cobb, 2016; NCTM, 2014; Smith & Stein, 2018); and

3. Utilizing evidence of student thinking as the basis of reflection (e.g., Bickel et al., 2017; West & Cameron, 2013; West & Staub, 2003).

As a result, the outcomes of content-focused coaching are reflected in a teacher's development in the following areas:

1. Mathematical content knowledge (e.g., West & Cameron, 2013; West & Staub, 2003);

2. Pedagogical content knowledge (e.g., Ball et al., 2008; Shulman, 1987); and

3. Ability to use "ambitious teaching practices" (e.g., Lampert & Graziani, 2009) that include facilitating meaningful mathematical discourse that builds on student reasoning as well as providing opportunities for productive struggle (e.g., Chapin et al., 2009; NCTM, 2014; Smith & Stein, 2018).

Description of Our In-Person Content-Focused Coaching Model

Like most coaching models, our in-person content-focused coaching model consists of three phases in which a teacher and coach collaboratively engage: the planning session, the lesson implementation, and the debriefing session. The planning session is focused on lesson design and co-construction of the lesson plan. Lesson implementation involves co-teaching the lesson. The debriefing session includes reflecting on the effectiveness of the lesson in terms of evidence of student learning. Throughout this cycle, the coach supports the teacher in connecting content knowledge and pedagogy to design instruction that increases opportunities for students to engage in a productive mathematical activity (Bickel et al., 2017; West & Cameron, 2013). These phases are discussed in detail below.

Planning Session

Throughout the planning session, the teacher and coach consider the *what*, *who*, *how*, and *why* of the lesson design (West & Cameron, 2013). The *what* of lesson design involves the coach and teacher analyzing mathematical learning goals for the students, the mathematics content in the task, and the potential for the mathematics task to address the learning goals. A critical component of the planning session is the co-construction of the mathematical learning goals for what students will come to know and understand as a result of engaging in the lesson (Smith & Sherin, 2019). The teacher and coach then select or design a mathematics task that aligns with the identified goals (Smith & Stein, 2018). Alignment of the task and goals requires identifying the learning opportunities for important mathematical ideas afforded by the chosen task. The teacher and coach also work together to identify the mathematics content standards addressed in the lesson and connections to content standards at other grade levels to consider prior knowledge/experiences students might bring to the lesson.

Once the mathematical learning goals have been established, the teacher and coach transition to the *who* of lesson design. In this phase, the coach and teacher think about the students and their existing knowledge about the task and learning goals. Specifically, the coach and teacher anticipate strategies students might use as they engage in the mathematics of the lesson (Smith & Stein, 2018). Anticipated student strategies include both mathematically correct strategies as well as possible misconceptions. There are three primary benefits to engaging in the mathematics of the lesson and anticipating student strategies. First, anticipating

student strategies supports the alignment of the selected task and the mathematical learning goals. If it becomes apparent that the chosen lesson/task might not align with the identified mathematical learning goals, the teacher and coach modify the task so that it is more likely that the goals will be met, choose another task, or further refine the goals. Second, anticipating student strategies and misconceptions prepares the coach and teacher to plan for and use ambitious teaching practices in mathematics—a key outcome in our guiding principle. Ambitious teaching involves using student thinking as a basis for instruction, so anticipating student thinking is critical in lesson planning. As a third benefit, coaches can support the development of teacher mathematics content knowledge through the collaborative work of anticipating student strategies and misconceptions.

The coach and teacher must also discuss the *how* of the lesson design, which includes analyzing instructional practices and structures used during the lesson. Because many instructional decisions are made when designing a lesson, the coach and teacher often select a small number of focus areas. For example, the teacher and coach may focus discussion on how to launch the lesson by considering how to provide access to the context and demands of the task for all students, how to maintain the cognitive demand, and how to address possible misconceptions at this initial phase of the lesson. Additionally, the teacher and coach may develop questions intended to assess and advance student thinking (Smith & Stein, 2018), especially questions that address anticipated strategies and misconceptions. The coach and teacher consider how to support productive struggle when students engage in the task (NCTM, 2014). Finally, the coach and teacher might draft the lesson summary by selecting and sequencing anticipated student strategies they deem productive to the mathematical goals (Smith & Stein, 2018).

Consideration of the *why* of the lesson design is woven throughout the entire planning session. Decisions made by the teacher and coach are grounded in the potential for student learning, student access, and student engagement—in other words, the

what, *who*, and *how* of the lesson design. This might include a conversation about why the lesson is being taught at this particular time or why the content is approached in the manner outlined in the chosen task.

Lastly, in the planning session, the coach supports the teacher in identifying a personal instructional goal that connects the co-constructed lesson to fostering ambitious teaching practices. The teacher shares a desired goal for improving one's own practice. Then the coach helps the teacher refine this thinking by focusing on high-leverage instructional practices that will impact student learning, such as facilitating mathematical discourse or creating a collaborative learning environment (West & Cameron, 2013). The teacher and coach also discuss ways in which the coach can gather evidence to support reflection on this instructional goal in the debriefing session and agree upon the coach's role during lesson implementation.

Lesson Implementation

A key component of our model is establishing and supporting an authentic partnership in which the teacher and coach share accountability for lesson design and implementation in service to student learning. This partnership is enacted during lesson implementation as the teacher and coach co-teach the lesson. In a coaching cycle, co-teaching requires that the teacher and coach remain actively engaged in the lesson, work in tandem, and collaborate (West & Cameron, 2013). In contrast, non-collaborative actions, such as the teacher and coach working separately with groups or individual students, do not fit our definition of co-teaching since such activities do not explicitly support collaborative learning opportunities for the teacher. We describe intentional co-teaching that supports teacher learning on *The Continuum of Teaching Responsibility* (Gillespie & Kruger, 2022), with the teacher having more responsibility for teaching and facilitating lesson activities at one end and the coach having more responsibility at the other end (see Figure 1). Each form of co-teaching is described below.
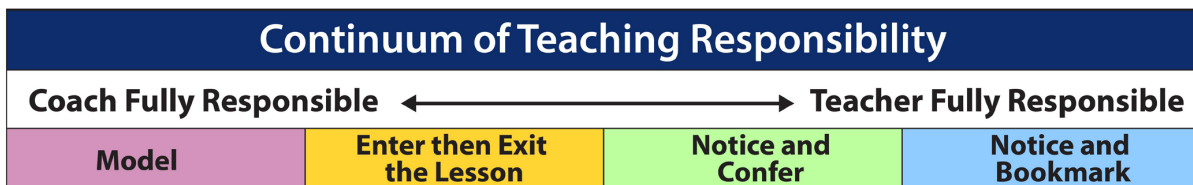
Model is a form of co-teaching on *The Continuum of Teaching Responsibility* in which the coach assumes the lead role in teaching the lesson. When modeling, the coach facilitates a portion of the lesson (e.g., launching a task or facilitating a summary discussion) while the teacher focuses on the coach's use of instructional strategies and the resulting actions of the students. During this modeling, the teacher records noteworthy events to discuss in the reflecting conversation. In special cases, a coach may *model* an entire lesson. However, a coach should most often *model* a single part of a lesson based on the teacher's instructional goals and learning needs.

Figure 1: Continuum of Teaching Responsibility Forms of Co-Teaching

Sweeney and Harris (2016) used the term "micro modeling" to emphasize the importance of a coach only modeling small portions of a lesson. Decisions about modeling must be collaboratively made by both the coach and teacher during the planning portion of the coaching cycle and should be based on the teacher's goals.

In a second form of co-teaching, *enter then exit the lesson*, the coach assumes teaching responsibility for brief moments (West & Cameron, 2013). In this form of co-teaching, the coach chooses critical moments in the lesson that can be leveraged to support teacher development, particularly related to the instructional goal. The coach intentionally contributes to the lesson with a clear goal and takes responsibility for lesson implementation at that moment. To avoid potential pitfalls when using this form of co-teaching, the teacher and coach must establish a clear signal for when the coach will join the lesson for a particular purpose. Additionally, the coach must then have a clear way to "hand back the reins'' to the teacher to avoid taking over the lesson. This is often referred to as "side-by-side" or "elbow-to-elbow" coaching (West & Staub, 2003).
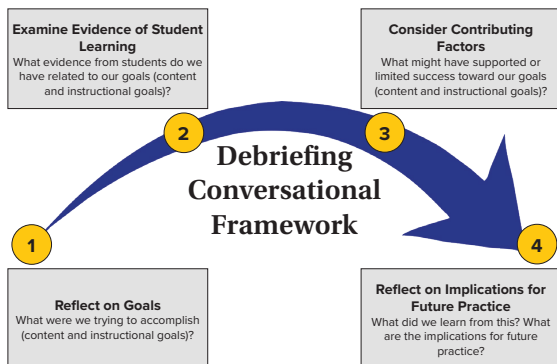
A third form of co-teaching, *notice and confer*, also has the teacher assuming primary teaching responsibility while the coach notices key moments of the lesson related to the mathematical and instructional goals (Sweeney & Harris, 2016; West & Cameron, 2013). However, in this form, instead of privately bookmarking a moment to discuss during the debriefing session, the coach confers with the teacher at the moment to discuss what steps to take. The coach might convey subtle, quick suggestions that can be implemented immediately and are often experimental, such as "What might happen if we...?" A coach might also share a noticing about student thinking and a probing question about responsive

Continuum of Teaching Responsibility			
Coach Fully Responsible ←——————————→ **Teacher Fully Responsible**			
Model	**Enter then Exit the Lesson**	**Notice and Confer**	**Notice and Bookmark**

actions, such as "I noticed..., what might we do in response to this?" In this form of co-teaching, the coach confers with the teacher only in moments that may have a significant impact on the trajectory of the lesson.

The final form of co-teaching we identify in *The Continuum of Teaching Responsibility* is *notice and bookmark*. This form also positions the teacher to assume the lead role in teaching the lesson while the coach notices key moments to "bookmark" for later discussion in the reflection conversation (Sweeney & Harris, 2016; West & Cameron, 2013). The coach records the bookmarked moments in a notebook without talking with the teacher or students. These bookmarked moments are used later in the debriefing session to spark conversation around the lesson's mathematical goals or the teacher's instructional goals.

It is important to note that in our model of content-focused coaching, each of these forms of co-teaching on *The Continuum of Teaching Responsibility* has value depending on the teacher's instructional goals. The critical feature is that both the teacher and coach remain actively involved in the lesson implementation (West & Cameron, 2013). This may take several co-teaching forms, even within a single lesson implementation. For example, when working with a teacher whose goal is to increase student discourse, a coach might micro model the launch of the lesson, *notice and confer* while students are exploring a task, and *notice and bookmark* while the teacher facilitates a summary discussion. Decisions about co-teaching should prioritize the learning needs and goals of the teacher without neglecting the learning needs of the students.

Examine Evidence of Student Learning
What evidence from students do we have related to our goals (content and instructional goals)?

Consider Contributing Factors
What might have supported or limited success toward our goals (content and instructional goals)?

Debriefing Conversational Framework

Reflect on Goals
What were we trying to accomplish (content and instructional goals)?

Reflect on Implications for Future Practice
What did we learn from this? What are the implications for future practice?

Debriefing Session

The debriefing session is centered around examining evidence of student learning related to the mathematical and instructional goals for the coaching cycle and reflecting on implications for the teacher's future practice (West & Cameron, 2013). During this phase of our model, the coach is guided by, but not restricted to, the following conversational framework:

1. Reviewing goals established in the planning session;

2. Examining evidence of student learning related to the mathematical and instructional goals;

3. Considering contributing factors that may have supported or limited success toward the mathematical and instructional goals of the lesson; and

4. Reflecting on implications for the teacher's future practice.

The debriefing session discussion is grounded in the mathematical and instructional goals that the teacher and coach co-constructed during the planning session. The conversation begins by reviewing these goals to ensure the reflective discussion is connected to the pre-established goals. The teacher and coach examine evidence of student learning to determine what aspects of the goals may have been achieved. For example, the teacher and coach may examine students' written mathematical work, bookmarked moments from the coach, video recordings, or transcribed notes from student discourse captured throughout the lesson. Engaging in a reflective conversation based on the evidence collected, the teacher and coach consider contributing factors that may have supported or limited success toward the mathematical and instructional goals of the lesson. The teacher and coach then collaboratively identify implications for future practice based on evidence of student learning and possible contributing factors. In doing so, the teacher and coach consider their own growth and next steps as professionals while also exploring the growth and needs of students and their learning of mathematics.

Challenges of In-Person Content-Focused Coaching

There are two primary challenges to successfully implementing an in-person content-focused coaching model. First, scheduling the coaching cycle activities can be problematic and time-consuming because the teacher and coach need to meet to plan, implement, and debrief the lesson within a short period. This typically begins with the coach and teacher identifying a specific date to co-teach the lesson based on the projected learning needs of students. The coach and teacher then schedule the planning and debriefing sessions, bookending the lesson within 24 to 48 hours. Thus, any changes to the lesson implementation phase of the coaching cycle could cause the need for rescheduling the entire cycle. Second, many districts lack access to high-quality content-focused coaching. Coaching positions are a substantial financial commitment for school districts, which often prohibit establishing these positions. Even for districts with the financial capacity for coaching positions, the coaches who fill these positions may not possess the necessary knowledge and expertise related to both content and pedagogy that content-focused coaching requires. Due to limited resources, districts may not be able to recruit coaches with these characteristics or provide professional learning experiences to cultivate these characteristics within existing educators. These challenges are particularly prevalent for school districts in rural areas that often lack access to high-quality coaching due to geographical barriers.

Our Guiding Principle for Content-Focused Coaching

Building from prior research and literature on coaching, the guiding principle for the design and implementation of our content-focused coaching model is as follows:

If coaches maintain an intentional focus on specific, high-leverage teaching practices during all coaching conversations and activities, they can reliably achieve positive outcomes related to teacher growth and student learning.

These high-leverage teaching practices include:

1. Focusing on key mathematical concepts and how students engage with those concepts (e.g., Bickel et al., 2017; West & Cameron, 2013; West & Staub, 2003);

2. Selecting and implementing high cognitive demand tasks aligned with clear mathematical goals for understanding (e.g., Gibbons & Cobb, 2016; NCTM, 2014; Smith & Stein, 2018); and

3. Utilizing evidence of student thinking as the basis of reflection (e.g., Bickel et al., 2017; West & Cameron, 2013; West & Staub, 2003).

As a result, the outcomes of content-focused coaching are reflected in a teacher's development in the following areas:

1. Mathematical content knowledge (e.g., West & Cameron, 2013; West & Staub, 2003);

2. Pedagogical content knowledge (e.g., Ball et al., 2008; Shulman, 1987); and

3. Ability to use "ambitious teaching practices" (e.g., Lampert & Graziani, 2009) that include facilitating meaningful mathematical discourse that builds on student reasoning as well as providing opportunities for productive struggle (e.g., Chapin et al., 2009; NCTM, 2014; Smith & Stein, 2018).

Description of Our Online Content-Focused Coaching Model

To improve access to high-quality coaching in rural areas, we redesigned our in-person content-focused coaching model as a fully online model while maintaining our guiding principle. In doing so, we carefully considered which coaching activities would be best suited to occur synchronously and which were better suited for asynchronous work. We recognized that synchronous work promotes the relationship between teacher and coach through collaborative conversations about teaching and learning. In contrast, asynchronous work allows for more flexibility in scheduling and time for individual reflection. These considerations transformed our in-person content-focused coaching cycle into our new online model, illustrated in Figure 2 and described below.

Figure 2: Image of Online Content-Focused Coaching Cycle
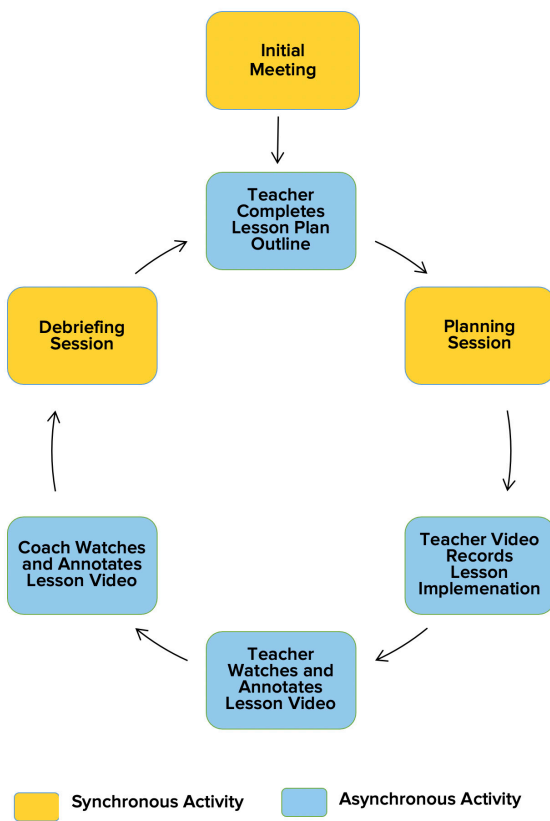
Initial Meeting

West and Cameron (2013) recommend that coaches "have a clear picture of who [the] teacher is" to determine a starting place for teacher learning (p. 87). Coaches must gather information to understand the teacher's values, beliefs, and goals to build a foundation for a positive and productive relationship (Wills & Rawding, 2019). In online coaching, building a relationship between the coach and teacher becomes even more important, as teacher/coach pairs are often in different geographical locations, and the partners may have never met (as opposed to coaching in one's own building/district where the coach may know the teacher being coached). Thus, we include this "initial meeting" as an integral component of our online content-focused coaching model. This initial meeting serves as a way for the teacher and coach to introduce themselves to each other, share their backgrounds, beliefs, and values, and begin to build a trusting relationship to engage in content-focused coaching together. The initial meeting takes place synchronously using video conferencing software, which allows the teacher and coach to see each other. In addition to serving as an introductory meeting for the teacher and coach, this session provides an opportunity to ask questions about logistics, technology, and scheduling so that time is not taken out of the planning session for these conversations.

Planning Session

After the initial meeting, as in our in-person model, the first part of our online content-focused coaching cycle is the planning session. This session utilizes both asynchronous and synchronous features to maintain the same goals and purposes of our in-person content-focused planning sessions. Before the planning session, the teacher uploads a proposed lesson task, a draft lesson plan, and/or curriculum materials to an online folder shared between the teacher and coach. The coach reviews these materials to prepare for the synchronous planning conversation.

As in the initial meeting, the synchronous planning session uses video conferencing software to allow the teacher and coach to see each other and view documents and materials simultaneously. Using the shared online folder and screen sharing features, the teacher and coach engage in a planning conversation with the same intentions as the in-person content-focused planning session. This includes collaboratively working on the mathematics of the lesson, articulating a mathematical goal for students, anticipating student strategies, and considering the *what*, *who*, *how*, and *why* of the lesson design. In addition, as in our in-person model, the coach supports the teacher in identifying a personal instructional goal that connects the co-constructed lesson to fostering ambitious teaching practices.

Lesson Implementation

Since our model takes place in a fully online space, the coach is not physically present in the classroom to co-teach the lesson with the teacher. Despite this significant change to the lesson implementation component of our coaching model, we found ways to innovatively use a video collaboration system to record the teacher implementing the co-planned lesson and maintain our guiding principle. In this section, we describe how we use the video collaboration system. Later, we highlight the benefits of incorporating video in content-focused coaching and the ways our use of video during lesson implementation maintains our guiding principle when coaching online.

The video collaboration system that we utilize (Swivl technology) consists of a robot paired with an iPad application to record video and markers to simultaneously record audio from different sources. The robot rotates and pivots, following a primary audio marker worn by the teacher or placed within a group of students. Once the lesson recording is complete, the video automatically uploads to a password-protected library account shared by the teacher and coach. Swivl includes an annotation feature that allows the viewer to pause the video and add a time-stamped written comment, which appears as a sidebar to the video.

After completion of the lesson and in preparation for the debriefing discussion, the teacher views the lesson recording and identifies a continuous clip or a collection of short clips related to their pre-established instructional goal. The teacher then uses the annotation feature in the Swivl video collaboration system to bookmark their thinking about specific moments during the selected portion of the lesson. The coach subsequently views the selected video segment(s) and adds observations and thoughts by responding to the teacher's annotations and bookmarking different moments. Figure 3 below shows a screenshot of the annotations recorded by a teacher and a coach in Swivl, referring to a specific moment in the lesson implementation.

Before the debriefing session, both the teacher and coach review all annotations in Swivl. In addition, the teacher uploads relevant classroom artifacts and student work to the shared folder for the coach to review. The video annotations and artifacts allow the teacher and coach to individually note evidence of student thinking and to reflect on lesson implementation related to the teacher's instructional goals prior to the debriefing session.

Debriefing Session

As in our in-person content-focused coaching model, the teacher and coach meet to engage in a reflective discussion about the lesson. For this synchronous online debriefing session, we use the same digital tools as in the planning session—a video conferencing platform and online folders for document sharing. This reflective discussion is anchored in the teacher and coach's initial viewing and annotation of the lesson video and analysis of lesson artifacts. Similar to an in-person content-focused coaching debriefing session, the coach is guided by, but not restricted to, the following conversational framework:

1. Reviewing goals established in the planning session (mathematical and instructional);

2. Examining evidence of student learning related to the mathematical and instructional goals using specific moments from the video, video annotations, and uploaded student work samples;

3. Considering contributing factors that may have supported or limited success toward the mathematical and instructional goals of the lesson; and

4. Reflecting on implications for the teacher's future practice.

Figure 3: Image of Annotations Captured in Swivl
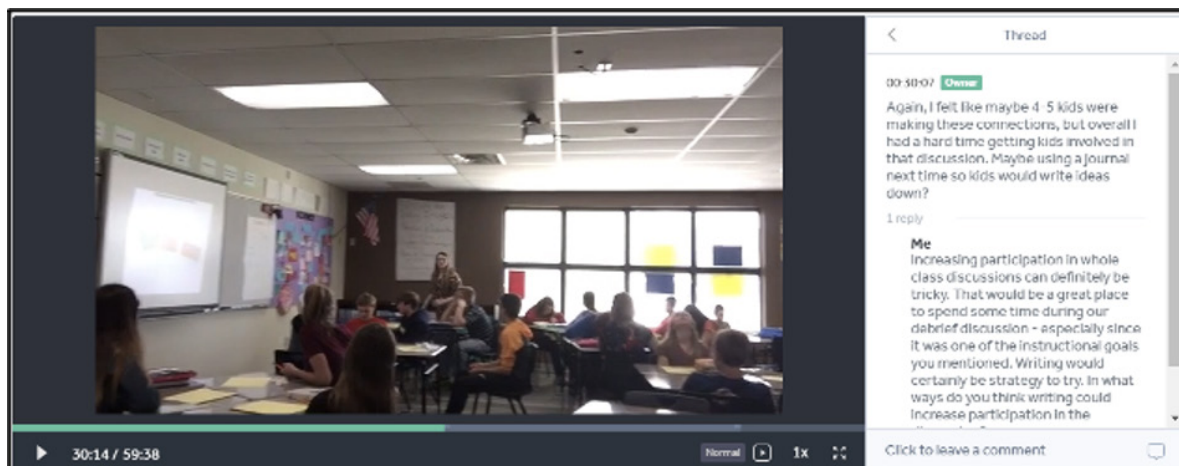
Affordances of Our Online Content-Focused Coaching Model

Through our reflection on the implementation of these two models of content-focused coaching (in-person and online), we identified affordances of our online content-focused coaching model that were added benefits of engaging in an online space. We have organized these affordances into two categories: (1) affordances that address the aforementioned logistical challenges of in-person coaching and (2) affordances that enhance the learning opportunities for teachers relative to in-person coaching. These affordances are discussed in detail below.

Addressing Logistical Challenges of In-Person Coaching

As described previously, in-person coaching is often constrained by scheduling and limited access to high-quality coaches. Our online content-focused coaching model addresses these constraints. First, our online content-focused coaching model helps teachers and coaches navigate scheduling limitations by providing greater flexibility in scheduling the lesson implementation. Unlike scheduling a fixed date for teaching the lesson, as would be necessary for the in-person model, once a teacher and coach schedule the synchronous planning and debriefing sessions, a window of time between these two conversations becomes available for the teacher to teach and record the lesson. This time flexibility allows the teacher to adjust the timing of lesson implementation without having to reschedule portions of the coaching cycle. Scheduling adjustments are common because of student readiness for the lesson and other unforeseen circumstances. One teacher who engaged in our online content-focused coaching model shared:

I think Swivl is easier than if someone was coming into [the classroom]. If [the coach] was coming into the school ... we would have had to reschedule three different times. As far as meeting with [the coach] before and afterward...everything was flexible.

Second, our model overcomes geographical barriers because the coach and teacher do not need to be in the same physical location. Another teacher who participated from a rural district noted:

I got a lot more out of [this professional development] because a lot of the things around here, it's the same stuff over and over. Unless I go to the city... I don't get anything new. We don't have a lot of math professional development.

The online format provides teachers, particularly those working in rural contexts, greater access to high-quality coaching.

Enhanced Learning Opportunities for Teachers

In addition to overcoming logistical challenges common to in-person coaching cycles, our online content-focused coaching model used video and annotations to enhance the learning opportunities for teachers.

Use of Video

Not surprisingly, we found that viewing videos of lesson implementation offers expanded opportunities for both the teacher and coach to reflect on the lesson implementation and student learning. Video provides teachers with an unbiased picture of their instructional practices and documents evidence of student thinking that often differs from what teachers perceive (Carson et al., 2019). The use of video also allows for repeated viewing and pausing at specific moments, increasing the quality of reflection from both the teacher and coach. Repeated viewing often reveals aspects of the lesson that may have been overlooked if only examined "in real-time." Pausing and reflecting allows both the teacher and coach to critically review specific moments of practice, prompting discussions based on the evidence in the video. One teacher noted the impact of using video:

> I think just videotaping yourself allows you to learn a lot about how you interact with the students and how you discuss different problems. It allowed me to kind of see that there are times that I lead the students more than I should be leading the students, as opposed to having them lead the discussion. It allowed me to really think about more [things] as I'm approaching a discussion in the classroom.

From our experience, the debriefing session discussions that teachers and coaches had in an online content-focused coaching cycle contrast sharply with conversations that occur immediately upon lesson completion in an in-person model. In such discussions, both parties rely on memory, the coach's notes, and retrospective perceptions of what transpired during the lesson. One of the online content-focused coaches described this affordance, noting:

> I feel like, in a lot of ways, I've been able to prepare better for a debriefing session online than when I am [in-person] because I can keep going back. I can find the evidence in the video exactly where it is. If need be, if the teacher has no clue what I'm talking about, we can always go back and watch that [moment].

This affordance is consistent with studies showing that video use in teacher education and professional learning encourages teachers to focus on moments of practice in productive ways (e.g., Gaudin & Chalies, 2015; Knight, 2014).

Use of Annotations

We also found that using annotations offers both the teacher and coach additional affordances unavailable in the in-person coaching cycles. Annotations allow both the teacher and coach to highlight facets of a lesson worthy of further discussion. The use of annotations also affords the teacher and coach insights into each other's perceptions of the lesson prior to the debriefing session. Both partners then have time to reflect on these aspects of the lesson before the debriefing discussion. The annotation feature of our online model thus supports a more targeted and focused debriefing conversation.

One of the teachers in our online content-focused coaching model commented on what she perceived as a benefit of the annotations, stating:

I really liked the annotation part of the Swivl. Being able to go in and tell [my coach] what I was thinking at this time, and everything like that, [let her know what I was thinking] when she was looking at it and I wasn't there. She could get more insight into it.

Teacher annotations also allow the coach to plan for the debriefing session more purposefully. One online content-focused coach shared:

I feel like going into a debriefing session online, I have a much clearer idea of how the teacher thinks the lesson went, just based on some of their annotations. Whereas in a face-to-face setting, you walk in cold. You could think things were great. They could think it's horrible or vice versa.

With the current model, both the teacher and coach had some sense of what the other partner thought about the lesson because of the annotations. They served to foreshadow conversations that may arise in the debriefing session.

Conclusion

Over the last several years, we have incorporated technology to create an online model of content-focused coaching to broaden teacher access to content-focused coaching and overcome some of the challenges associated with in-person coaching models. As we constructed our online model, we remained committed to the specific high-leverage practices and desired outcomes related to teacher growth contained in our guiding principle. Our commitment to these practices and outcomes, grounded in seminal mathematics education literature and our experiences with in-person coaching, allowed us to provide teachers with high-quality coaching in a fully online space.

Our online content-focused coaching model allows teachers greater access to expert resources and reduces geographical barriers while at the same time providing more flexibility to engage in high-quality job-embedded professional learning. This model provides a teacher and coach opportunities to engage in lesson planning independently and collaboratively. At the same time, they reap the benefits of examining classroom practice through the use of video and collaborative reflection. We hope that other K-12 educators, leaders, coaches, researchers, and those supporting teacher development in various contexts can use our work to support their efforts in content-focused coaching to cultivate ambitious teaching practices in mathematics.

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