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Mentoring the Mentors: Hybridizing Professional Development to Support Cooperating Teachers' Mentoring Practice in Science

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This article describes key features of a hybrid professional development (PD) program that was designed to prepare elementary classroom teachers to mentor preservice teachers for effective science instruction. Five classroom teachers who were new to our mentor training participated in the study to document the impacts of the PD sequence. The PD combined an in-person immersion into the components of effective science instruction with online modules centered on learner-supportive mentoring practices. The authors detail key aspects of this hybrid program and discuss its impacts on the cooperating teachers' ability to facilitate effective mentoring conversations with preservice teachers. Findings indicated that mentors who engaged in the hybrid face-to-face and online PD more effectively coached their mentees and displayed specific shifts in their approach to mentor conversations. Participants showed statistically significant increases in their ability to use coaching as a default mentoring stance, to focus on evidence of students' science learning, and to draw on a consistent framework for effective science instruction for their conversations. These findings support a hybrid model of PD for mentoring and create potential for exploring a fully online sequence to promote effective mentoring in future work

Teaching science demands a complex repertoire of practice requiring preservice teachers over the course of their preparation to develop "specific and skilled" assessment practices, pedagogies, and other supports for students' learning (Windschitl, Thompson, Braaten, & Stroupe, 2012, p.879). Recently, researchers have articulated the need for high-quality clinical practice opportunities with specific mentoring support to afford preservice teachers scaffolded opportunities to enact their growing understandings of ambitious science teaching (American Association of Colleges for Teacher Education, 2018; Darling-Hammond, 2014; Field & Scoy, 2014; Goodwin, Roegman, & Reagan, 2016; Guha, Hyler, & Darling-Hammond, 2016; McDonald et al., 2014).

As teacher preparation programs strive to provide access to high-quality clinical practice, specific kinds of expertise that cooperating classroom teachers can offer in supporting preservice teachers during their initial classroom-based, clinical experiences should be explored: Cooperating teachers understand the learning expectations for their grade level, they have longitudinal understandings of their students and the contextual factors that influence their learning, they know and can apply developmentally appropriate pedagogies, and they have tried-and-true approaches to classroom management that support that learning.

Although cooperating teachers offer these important perspectives and can provide crucial support to preservice teachers, many are not sufficiently prepared to teach science (Banilower et al., 2013; Windschitl et al., 2012) and may not have mentoring expertise to guide the preservice teachers' learning in primary science education (Hudson, 2007). Thus, there is a strong need to "mentor the mentors" and provide efficient, effective, and high-quality professional development (PD) for cooperating teachers to support preservice teachers' growth.

Our research team previously addressed this need through a 5-year, National Science Foundation grant-supported longitudinal study. One component of this research was to develop and study a mentor preparation program grounded in research-based elements of effective science instruction (ESI; Banilower, Cohen, Pasley, & Weiss, 2010) and strategies to structure and facilitate learner-focused mentoring conversations (Wellman & Lipton, 2017). A focus for the project was PD for cooperating teachers that included several days of face-to-face PD to introduce the components of ESI to place the participants in the role of learners using science content immersions, and to provide strategies for learning-focused mentoring conversations, with an emphasis on coaching as a default stance when mentoring preservice teachers (Lipton & Wellman, 2007).

The structure of the mentoring PD was grounded in research that cites the efficacy of including opportunities to practice mentoring novice teachers in the midst of guided practice over time (Bradbury & Koballa Jr, 2008; Meyer, 2002). This earlier study revealed that cooperating teachers who participated in the PD sequence showed statistically significant increases in their beliefs about ESI and their ability to facilitate effective mentoring conversations about science lessons taught by the preservice teachers (Miller, Hanley, & Brobst, in press). Furthermore, the preservice mentees showed statistically greater gains in their beliefs about ESI than did their nonmentored peers.

Although our research found significant changes in mentor teachers' mentoring practices and understanding of ESI, we faced several challenges when the grant and its financial support ended. In order to sustain and even improve cooperating teachers' access to PD for mentoring, we needed a solution that would (a) allow us to scale the professional development to a large number of cooperating teachers, (b) be cost effective and preferably free, (c) provide flexible access that allows cooperating teachers to engage in the PD as their schedules allow, (d) enable access across a broader geographic region than is possible with in-person PD, and (e) capable of being completed in a relatively short amount of time, given teachers' multiple commitments. These sustainability challenges are not unique to our project, but are common among grant-supported projects that seek to sustain innovative pedagogical practices (Owston & Sinclair, 2006).

In order to sustain our PD, we investigated how online learning modules would help us to meet sustainability criteria. Online professional development models have been effective in supporting teachers' ability to explain and communicate solutions to problems of practice (Wall, Selmer, & Bingham Brown, 2016) and mediate challenges with time and travel distance (Elliott, 2017). However, researchers have also found that online professional development, unless carefully constructed, can present challenges such as producing gaps in participants' understandings of key ideas and limiting participants' engagement and motivation (Lebec & Luft, 2007).

As an initial proof-of-concept step in this process, we created a hybrid in-person and online PD model to collect evidence that placing some of the PD content online was both feasible and could still positively impact teacher learning (Borko, Whitcomb, & Liston, 2009). We were curious about whether moving the mentoring PD to online learning modules could offer a solution to the challenges, yet still maintain the quality and results of more intensive face-to-face PD on the cooperating teachers' ability to facilitate and successfully engage in effective mentoring conversations.

To this end, we developed a series of three online mentoring modules to broadly disseminate our mentoring PD in an engaging format that utilizes animations, case studies, and user interactivity. The modules were designed to be completed in less than 1 hour. We coupled these online modules focused on effective mentoring strategies with a half-day, face-to-face professional development on the elements of ESI.

The following research question guided our study: How does a hybrid of online and face-to-face PD in ESI and mentoring impact the quality of mentors' work to support preservice teachers? This paper shares the results of this proof-of-concept study of hybrid PD. The paper begins with a review of the literature on ESI and effective mentoring, briefly describes the study's theoretical framework, and describes investigation of the efficacy of this hybrid approach to mentor development.

Literature Review

Our team delved into the research literature to identify key dimensions of our hybrid PD sequence that would help prepare mentors to effectively support mentees' science teaching. Out of this inquiry, four components emerged, including the need to: (a) develop mentors' understanding of the components of ESI (Banilower et al., 2010; Weiss, Pasley, Smith, Banilower, & Heck, 2003); (b) develop mentors' ability to use a palette of support strategies to guide novices in their instructional decision-making (Achinstein & Athanases, 2006; Guha et al., 2016; Lipton & Wellman, 2007; MiraVia, 2012; Wellman & Lipton, 2017); (c) emphasize the use of data and evidence of student learning when engaging in mentoring conversations versus an emphasis on the novice's teaching practices (Darling-Hammond, 2014; Stobaugh, Tassell, & Norman, 2010); and (d) maximize teachers' learning through hybridizing asynchronous and traditional professional development (Clary et al., 2017; Fishman et al., 2013; Limperos, Buckner, Kaufmann, & Frisby, 2015; Moon, Passmore, Reiser, & Michaels, 2014; Thomas, 2011).

Effective Science Instruction

In recent years, researchers have begun articulating a common vision of ESI oriented around core practices (Grossman, 2018; McDonald, Kazemi, & Kavanaugh, 2013; Banilower et al., 2010; Barnhart & van Es, 2015; Bybee et al., 2006; Miller et al., In press; Windschitl, Thompson, & Braaten, 2008a, 2008b, 2011, 2018). Although the language used to describe core practices for teaching science varies depending on the locale (Bybee et al., 2006; Windschitl et al., 2018), key practices described across core practice frameworks for science teaching include asking questions, using models to help develop explanations about natural phenomena, planning and carrying out investigations, analyzing and interpreting data, constructing evidence-based claims about phenomena, and obtaining, evaluating, and communicating information (NGSS Lead States, 2013). Rather than emphasizing the primacy of a single mode of instruction (lecture, demonstration, hands-on, inquiry, etc.), a priority is given to students' thinking about scientific ideas aligned to specific learning goals and relating those ideas to real-life phenomena.

Banilower et al. (2010) distilled the research on ESI into the following four elements that operationalized ESI for our PD program:

1. Eliciting initial ideas: Students need opportunities to surface and record their initial ideas about scientific phenomena so these ideas can be supported, enriched, and/or challenged by evidence of the phenomena.
2. Intellectual engagement with relevant scientific phenomena: Students need opportunities to investigate meaningful questions, engage with relevant phenomena, and to collect and analyze data.
3. The use of evidence to make and critique scientific claims: Students need opportunities to use evidence to make scientific claims and/or critique the claims of others.
4. Sense-making: Students need opportunities to make sense of scientific ideas in light of data, make sense of their current thinking with respect to their initial ideas, and make sense of the scientific idea in light of related scientific phenomena.

As described in the following section, the hybrid PD that resulted used this ESI framework to foster a common language for science instruction among the mentors and mentees.

Mentoring Strategies

When teachers mentor novices, they understandably want to draw from their wealth of experience and expertise to provide the novices with advice and suggestions about strategies that they have found to be effective. Lipton and Wellman (2007) described this approach to mentoring as a consulting stance and noted that a default toward the consulting stance can short-circuit the learning process for novice teachers because it focuses on providing answers versus engaging the novice's thinking and problem-solving.

In contrast, a coaching stance emphasizes the mentors' ability to elicit the mentees' thinking to help the mentee engage in the process of "accessing internal resources and developing capacities for self-directed learning" (Lipton & Wellman, 2007, p. 25). The coaching stance helps mentees think about a lesson by employing strategies like asking them to consider evidence, soliciting and paraphrasing their ideas, and suggesting connections.

Coaching should be the default stance for mentors, because it enables mentees to develop their inner professional voice and ask themselves questions that reflective teachers ask after a lesson, such as (a) To what extent did students develop their understanding of the targeted ideas for the lesson, and how do I know? (i.e., What is my evidence?); (b) What helped or hindered students' understanding of the targeted ideas? and (c) What are the next steps to support students' learning?

Because of the importance of soliciting mentees' thinking and problem solving, the online modules described here emphasize how mentors can shift their default mentoring stance from consulting to coaching yet use the two stances flexibly in order to meet the needs of their mentees (Wellman & Lipton, 2017). As described in more detail in the theoretical framework section, situated learning theory (Lave, Wenger, & Hanks, 1999) frames the experience of the mentor teachers, as they apply core practices and strategies from the hybrid PD to their mentor conversations.

Use of Student Learning Data. When mentors and mentees meet to discuss lessons taught by the mentees, what is the most productive focus of those conversations? Rather than focusing on the teacher's choices and actions, emphasizing student learning data creates a safe space for the mentor and mentee to collaboratively discuss the strengths and problematic aspects of students' thinking and how the lesson supported or inhibited students' learning. Focusing on student actions allows teachers to consider students' thinking and to identify factors that helped or hindered students' learning.

Student learning data can include observations of students' conversations, examinations of student work, and assessment data. This focus on student learning data during mentoring conversations creates a safe space by using a "third point," where mentors and mentees focus conversations "not on the teacher's teaching practices, but on the factors producing positive results as well as performance gaps" (Lipton & Wellman, 2007, p.31). We developed and incorporated into the online modules the "Stoplight Model for Reflection" to enable mentors and mentees to focus on student learning during their post-teaching conversations.

Hybridizing Online and Face-to-Face Teacher PD. The use of online learning is still a relatively new modality for teacher PD in science. Professional developers have begun to utilize online learning for its potential to engage teachers in working with the practices and disciplinary core ideas in the National Research Council's *Framework for K-12 Science Education* (National Research Council, 2012) and the *Next Generation Science Standards* (NGSS Lead States, 2013). Within the last decade, science education researchers have begun exploring the costs and affordances of online PD, both as a replacement for traditional face-to-face PD and as a hybrid that incorporates aspects of both approaches.

Such research has included investigations into the use of rich video cases (Limperos et al., 2015), video clubs (Barnhart & van Es, 2015; van Es, 2012), face-to-face teacher discussions and distributed leadership (Michaels, Moon, & Reiser, 2018), and asynchronous learning (Thomas, 2011). The findings from these studies indicate that such approaches through online PD can increase the capacity of systems to provide and scale teacher PD and offer possibilities for innovative and dynamic approaches to teacher learning.

While some affordances of online systems simply cannot be matched in traditional settings, active sense-making and connections to teachers' practice are rarely built into such learning opportunities, because they are difficult to operationalize and scale within an online learning environment (Moon et al., 2014). Creating purely online teacher professional learning for science instruction is challenging, because in order to be effective

PD needs to be embedded in specific disciplinary content, needs to involve active sense-making and problem solving, and needs to provide teachers opportunities to engage in activities related to their own problems of practice.

Thomas (2011) also noted that, while teachers value and want more online experiences, they do not desire a total replacement of traditional face-to-face PD. Thus, we created a hybrid model for our science mentoring PD that approached the more general mentoring strategies through an online learning model and the framework for ESI through a brief, but more traditional, face-to-face model.

Theoretical Framework

The research on ESI, effective mentoring, and use of student learning data in mentor conversations drove the development of a hybridized PD model where participants engaged in both online and face-to-face PD. Emerging from our review of the literature is a theory that places student learning at the heart of any mentoring conversation between mentors and mentees. Our goal was to support the mentors' ability to coach the novice teachers toward a set of core practices (as identified by Grossman, 2018) that emphasize ESI to support students' learning. This emphasis on core practices aims to treat the practical work of teaching as work that entails "complex thought, professional judgment, and continual reflection" (Grossman, 2018, p. 2). This approach is different from previous eras in teacher education, where the focus was on the exhibition of discrete skills divorced from professional judgment.

Accompanying an emphasis on core practices, the framework undergirding our hybrid PD model is also rooted in a theory of situated learning. Opportunities to inquire collectively into teaching and artifacts of practice promote a social orientation toward learning where teachers, including those with different levels of experience, work together to create knowledge (Lave et al., 1999; Vygotsky, 1978). Smagorinsky, Cook, and Johnson (2003) used the term, "nexus of practice" (p. 10), to describe purposeful environments where teachers participate in focused conversations with each other about teaching and learning artifacts such as observations, lesson plans, and samples of student work. Such social interactions refine teaching practices and support a key aspect of teacher learning: the ongoing processes of comparing and checking understanding with capable others.

Learning is a collaborative, versus solitary, enterprise, where teacher knowledge is coconstructed with experienced peers. Through such social discourse, people learn how to justify their claims with evidence and how to ask informed questions of each other to refine their work. This theoretical perspective emphasizes asking questions instead of pursuing answers with colleagues as a highly effective way of learning.

Using these theories of core practice and situated and social learning, we structured the hybrid PD model to enable participants first to connect to their own problems of practice, to participate in a science content immersion, and to engage in sense-making in a live setting. These opportunities to learn are still somewhat limited through purely online platforms and are often more effective in live settings (Moon et al., 2014).

Following the live PD, participants learned about effective mentoring strategies through a self-paced online delivery of PD before engaging in mentor conversations with preservice teachers. Details on the content and structure of this model are included in the following sections.

Methods

ESI and Mentor PD Program Design

We created a series of three 15-minute modules to help mentors learn how to structure and lead effective mentor conversations was provided online. The mentor PD was moved to an online format first because the framework for mentoring was designed to be generalizable across domain areas and grade levels (Wellman & Lipton, 2017), so it was more conducive to online delivery for a range of educators. However, a crucial part of our PD emphasized domain-specific understandings for science teaching, which are often better situated in live settings (Kopcha, 2012). We, therefore, provided a short in-person PD session that brought into view the dimensions of ESI to complement the online modules featuring best practices for mentoring novice teachers.

While the domain-specific framework is needed to establish a common language between mentors and mentees, the online mentor modules more generally inform mentors how to focus on student learning to inform the teacher's next steps. Thus, in our hybrid PD model, the online mentor modules illustrate how mentors should lead effective mentor conversations, and the domain-specific focus on science is delivered through face-to-face engagement.

Online PD. We created a series of three 15-minute modules to help mentors to learn how to structure and facilitate an effective mentoring conversation (Miller et al., 2018). The modules employ animations and animated case studies (Figures 1 and 2) to inform viewers how to structure conversations to enable both mentors and mentees to become authentic thinking partners to support students' thinking and learning. The modules also emphasize how to use evidence of student learning to support the conversations.

Figure 1. *Screenshots of the mentoring modules animations.*

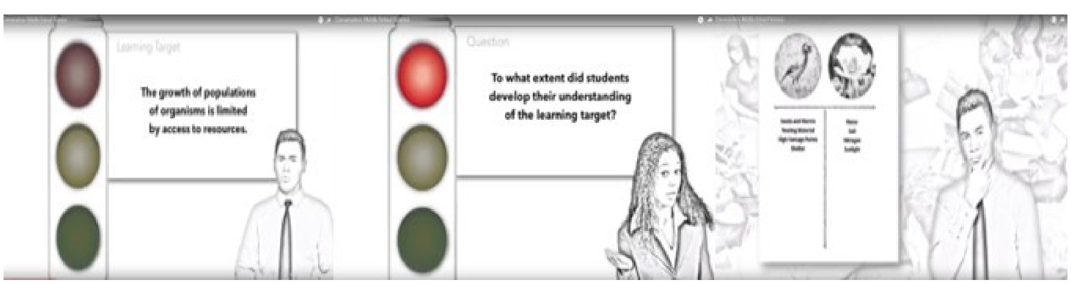

Figure 2. *Screenshots of animated case study for middle school science.*

Finally, the modules model how mentoring strategies can be applied across learning domains through three case studies that feature sample conversations about lessons taught in mathematics, science, and language arts, ranging from Grade 3 to high school. In addition, the delivery of downloadable tools and model conversations through a visually driven medium that includes animations, visuals, and accompanying audio narration is more dynamic than what is often possible in traditional face-to-face PD. The full online modules can be viewed at http://bit.ly/mentormodules.

Due to the importance of soliciting mentees' thinking and problem solving, our online PD emphasizes how mentors can shift their default mentoring stance from consulting to coaching to allow the mentees to engage in problem solving within a situated and socially constructed context (Lave et al., 1999; Miller, 2003). However, because they are working with novices, we also highlight the need to use the two stances flexibly in order to meet the needs of their mentees (Wellman & Lipton, 2017).

The modules direct mentors toward the use of coaching as a default stance, while providing a few consulting strategies to be used when mentees do not have the ability to think through a problem or to strategize next steps without the additional support that consulting provides. The online modules help mentors understand when and how to appropriately apply these stances and their associated strategies during their conversations.

We also developed a "Stoplight Model for Reflection" (Figure 3) and incorporated its steps into the online modules to help mentors reflect on observed lessons and use when facilitating mentor conversations. The choice of a traffic signal was deliberate, directing mentors to first stop (red) and think about student learning rather than instructional moves and to focus the conversation on students' understanding of the learning target rather than classroom management. The Stoplight uses prompts like, "To what extent did students develop their understanding of the learning target?" to anchor the conversations on observations of students' learning.

Once conversations have this student learning focus, mentors are free to slow down (yellow light) and share the most salient factors that helped or hindered students' understanding. Finally, mentors and mentees can go ahead (green light) with prompts such as, "What are the next steps to support student learning?" to strategize the next steps to support students' learning.

In-person PD. We also developed a 3-hour in-person PD to develop the mentors' framework for what to talk about in a mentoring conversation focused on science instruction. This face-to-face format capitalized on the particular affordances of live PD. During the face-to-face PD, mentors engaged in a variety of activities to learn about the elements of ESI and how those elements are organized in a science lesson. Mentors watched and analyzed a video that featured a typical classroom science investigation, read and discussed an article that provided a purpose for the ESI framework (Banilower et al., 2010), and identified what each element might look like in an elementary science lesson.

Mentors then participated in a content immersion on light and shadow that allowed them to experience the elements of ESI as learners, providing an insider's perspective of the framework in action. Finally, mentors practiced situating the elements they experienced during the investigation on the observation guide. These in-person experiences allowed mentors multiple opportunities to understand the same framework their mentees learned throughout their science teacher training program.

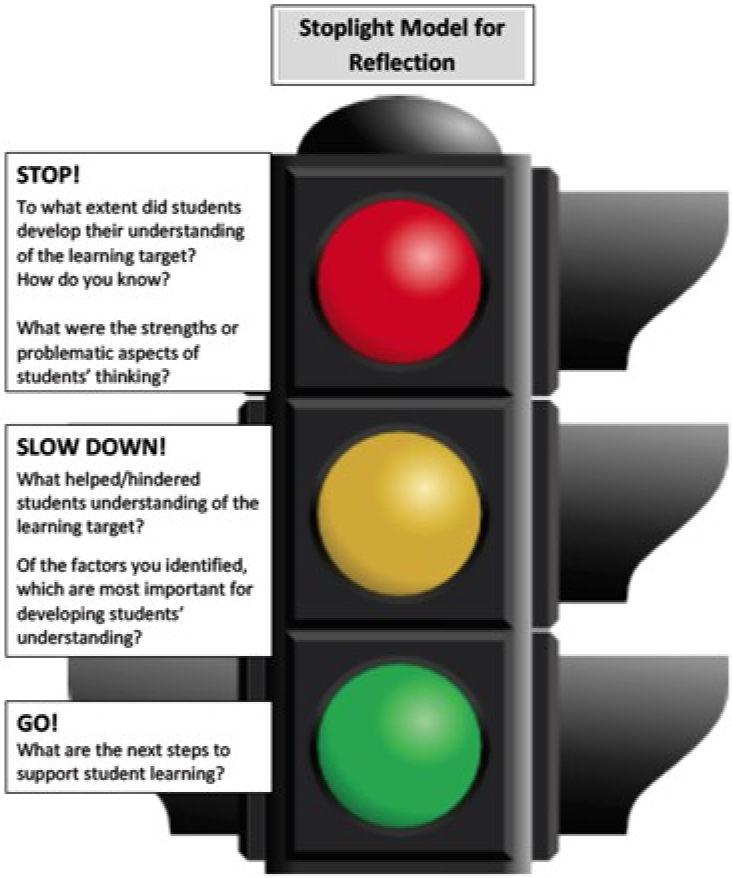

Figure 3. *Stoplight Model for Reflection*

In addition to the science content providing a common framework for mentors and mentees, the structure of the PD was also an important aspect of the ESI portion. The face-to-face format allowed mentors multiple opportunities to converse with each other and request additional information throughout the PD so that the content presented met the needs of participants. Mentors interacted with each other and the facilitators in a conversational format so that specific topics could be prioritized based on participants' questions and needs. As a result of this dynamic structure, the environment was conducive to troubleshooting problematic aspects of individual situations and addressing specific classroom practices that emerged throughout the PD.

Study Context and Data Sources

This study took place in the context of an elementary science methods course at a Pacific Northwestern university. Mentors were cooperating teachers at four nearby elementary schools who hosted mentees in their classrooms in conjunction with the science methods course. Mentees were elementary preservice teachers working in groups of three to plan and deliver 6 weeks of a science unit, using the elements of ESI to frame their lessons. Mentees rotated the role of lead teacher for each lesson, so that each group member taught two complete lessons while other group members provided instructional support.

Following each individual lesson, mentees formally met with their mentors to discuss the lesson. Cooperating teachers were provided a handheld digital audio recorder, which they used to record these conversations averaging 10-15 minutes in duration. The first round of mentoring conversations were recorded prior to the hybrid PD. Mentor teachers brought the audio recorders with them to the PD session, where research team members downloaded audio files, erased original files from recorders, and then returned recorders to participants. Mentor teachers recorded a second round of mentoring conversations after the hybrid PD, and research team members traveled to the cooperating elementary schools to collect recorders. During each lesson (both prior to and after the PD), mentors observed and took notes using a modified AIM classroom protocol (Horizon Research, 2014) to operationalize the components of ESI within an observation framework (see Appendix A).

Sample

Twenty-two mentor teachers from four elementary schools in predominantly white suburban neighborhoods completed all of the data collection for this study. Because many of these teachers had participated in one or more in-person mentoring related PD experiences and associated research studies prior to this study (Miller et al., in press), we analyzed data from the mentor teachers new to our PD program to isolate the effect of the newly developed hybrid model. Thus, the findings described below are drawn from a subset of five participating teachers who had not completed any prior face-to-face mentoring PD offered by our research group. Each of the teachers in this subset had previously mentored one or more preservice teachers, and each had over 5 years of classroom teaching experience.

Participating teachers were comfortable using technology to support instruction, but none were using technology-driven curricula and students had limited access to devices in the classroom. A total of 17 mentoring conversation recordings (nine held prior to PD and eight held after PD) from this subset were available for our analyses. Conversations were transcribed verbatim by a commercial transcription service.

Analysis

Mentoring Conversations

The primary data for this study were the aforementioned transcripts of mentor teachers' conversations with mentees prior to and following the PD. Using the framework of our mentoring PD program (What to talk about / How to talk about it) as a starting point, research team members developed coding categories for thematic analyses of transcripts and practiced applying the codes prior to data analysis (Miles & Huberman, 2013).

For the thematic analyses, two or more researchers independently coded each mentoring conversation transcript using QSR NVivo software and then met to resolve any coding discrepancies, resulting in high interrater reliability. We made three coding passes for each transcript, focusing each pass on one of the following coding categories: (a) Content of the mentoring conversation (ESI, General science pedagogy, Classroom management, Miscellaneous), (b) Data Use in the mentoring conversation (Student data related to learning target, Other data), and (c) Mentoring Stances employed in the mentoring conversation (Coaching, Consulting). Once coding was complete, we used the NVivo software to generate reports of coding frequency data for each individual transcript then combined data across transcripts to generate aggregate coding frequencies.

We also analyzed the audiotaped mentoring conversation data set qualitatively to complement the quantitative coding frequency data. This analysis surfaced general themes from the participants' pre- and postmentoring conversations (Miles & Huberman, 2013; Yin, 1984) and provided examples of conversational exchanges between mentors and mentees to illustrate salient themes across the data set (Merriam & Tisdell, 2015).

Written Reflections

To complement the conversational analysis, we also analyze participants' written responses to two reflective prompts prior to and after the in-person and online PD. The two prompts were as follows:

- "Describe an effective mentoring conversation. What is the mentor doing? What is the mentee doing?"
- "What should be the main focus of a mentoring conversation?"

We analyzed and coded the participants' written responses for common themes before and after the intervention.

Findings

When comparing mentor conversations held after the hybrid PD to those held beforehand, we observed notable changes in both the content and structure of discussions. Conversations held prior to the PD were focused first and foremost on classroom management (54% on average), whereas those held after PD were overwhelmingly focused on elements of ESI (76% on average). In concert with this shift, we observed an increase in discussion of student data related to the learning target from an average of 14% in the conversations prior to the PD and 23% of the post-PD conversations (Figure 4).

The structure of mentoring conversations also underwent a notable shift in response to our PD. In conversations prior to the PD, cooperating teachers overwhelmingly utilized a consulting stance and were also the dominant voices in the conversation, responsible for 67% of coded text. After PD, conversations alternated nearly evenly between coaching and consulting stances, and preservice teachers held much more of the floor – accounting for 45% of dialog on average (Figure 5).

The following brief transcripts further illustrate how cooperating teachers guided mentor conversations prior to and after participating in the hybrid PD. These excerpts are typical of conversations from our data set and demonstrate the shift in content and structure of conversations. The first exchange between a cooperating teacher mentor (CT) and preservice teacher mentee (PST), occurred after the mentor teacher observed the mentee's science lesson in a space unit, prior to the mentoring and ESI hybrid PD. The amount of talking the mentor (CT) did compared to the mentee (PST) is notable, as is the way the mentor was focused on behavior management of students during the lesson, versus evidence of students' learning.

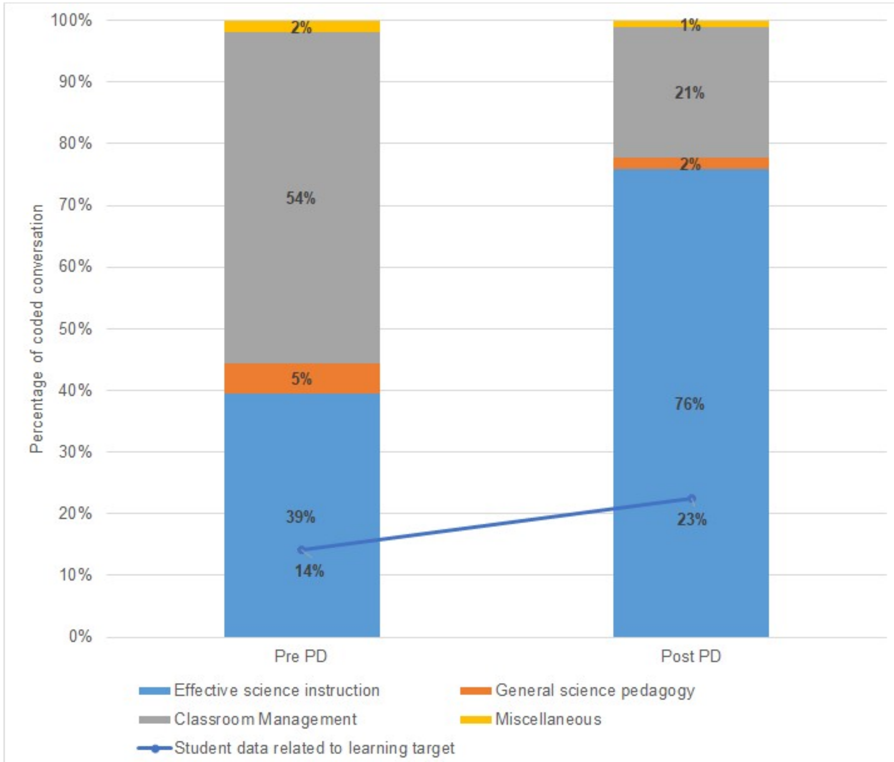

Figure 4. *Changes in content focus of mentor conversations in response to hybrid PD (*n = *9 prePD conversations;* n = *8 postPD conversations).*

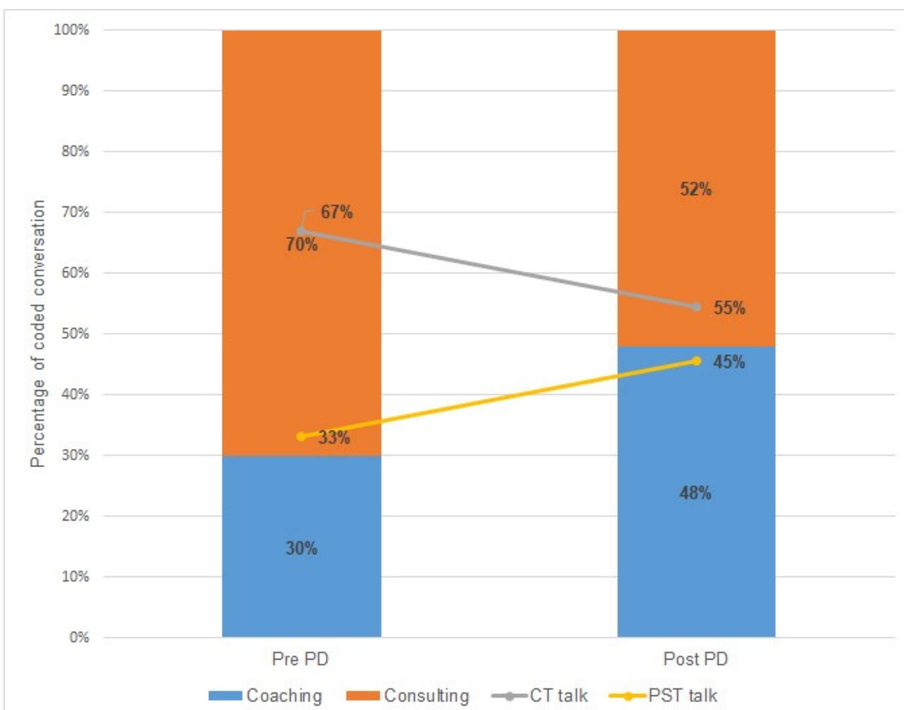

Figure 5. *Changes in structure of mentoring conversations in response to PD (*n = *9 prePD conversations;* n = *8 postPD conversations).*

Conversation 1 - Before PD

> CT: And we do need to make sure that they can – They listen and follow those directions and that is – and that's what we are going to be doing all year long with these kids. So, that will be, I'd say, one of our goals –
> PST: Mm-hmm.
> CT: Um, is to make sure that, before you start talking –
> PST: Right.
> CT: – when you ask for their attention
> PST: Mm-hmm.
> CT: – you have that wait time. Last time we met our main focus was classroom management. Um, you had done a great job and still continue to do a great job knowing the content and knowing what is coming up. And your new step or your take away last week was to, um, make sure that you had the classroom management under control and could possibly make a new, um, attention signal, which you did.
> PST: [laughs]
> CT: And you made an amazing attention signal, um, where you said, "I'm blasting off in five, four, three, two, one," and then you said, "To infinity," and then the kids are supposed to put their hands in the air and go, "And beyond." And it was an excellent, they were quiet, they loved it. You used it at least 15 times –
> PST: [laughs]
> CT: – to really solidify, um, that and so, um, so much so that they were all in to it. And my next step would be when they say beyond –
> PST: Mm-hmm.
> CT: – make sure that they stop –
> PST: Yes.
> CT: – and actually have their voices quiet, 'cause they wanna keep talking.
> PST: [laughs] Yes.

While the mentor suggested reasonable strategies to improve the upcoming lesson, the mentee was not provided opportunities to reflect on her instructional moves, on her students' learning, or to investigate solutions to their instructional challenges. In terms of the content of the conversation, the mentor did not mention the learning target or evidence of student learning but rather focused on student behaviors and what the mentee should do in the future to better address those behaviors.

In contrast, the next conversation occurred after the same mentor observed the mentee teaching a space lesson, but it took place following the PD for mentors. The mentor (CT) focused on student learning and employed a coaching stance to support the mentee (PST).

Conversation 2 - After PD

(Emphasis added in bold type)

> CT: **What are some of the ideas that you wanted them to understand as they progressed through this lesson today?**
> PST: Well, the lesson was [focused on that] the Earth is round. It was still assuming that kids would be thinking the Earth was flat.
> CT: Mm-hmm.
> PST: So, I thought – I was actually going to connect it more to like why are objects in space round? Why are there so many round objects in space? But then, I put in a lot of review, because I thought – Because I wanted to, like, didn't want

> to run out of things to do, because it's such a small concept. And so – so ended up – We ended up spending the whole time on review, I felt. Not whole time, but like a lot of time.
> CT: Mm-hmm.
> PST: And they probably could've moved on earlier.
> CT: Mm-hmm. Mm-hmm. **Do you think they understood what they were reviewing?**
> PST: Ooh. Ooh. Uh – Probably not as well as ideally. Yeah. Because I told them we were wrapping up distance, and studying shape. So – so, that's what we did. And we did, like, a lot of evidence and stuff. But yeah. I just felt like I dwelled on it to a –
> CT: You –
> PST: Dwelled on –
> CT: On what?
> PST: On, like, evidence of the Earth's shape.
> CT: You mean at the end? Like, when you were doing the end part?
> PST: I don't know. [laughs] Well, I – I don't know. Yeah.
> CT: …**So, um, I wonder if they understood what the learning target was from looking at that picture**…

These two short excerpts highlight typical shifts in the structure and content of conversations following the hybrid PD. In the first conversation, the cooperating teacher did most of the talking and utilized a consulting stance by sharing observed strengths and weaknesses of the lesson and telling the preservice teacher what changes to make in future lessons. The cooperating teacher also focused on classroom management and the teacher's actions during instruction.

The content and structure of the second excerpt was very different. The cooperating teacher attended to student learning in relation to the goal of the lesson rather than to classroom management. Similarly, the preservice teacher did most of the talking in the second conversation, which is typical of the coaching stance, where the cooperating teacher asks questions to help the preservice teacher reflect on student learning.

These differences in the second conversation can be attributed to the goals of the hybrid PD, namely, (a) to utilize the online modules as opportunities to learn about coaching as a default stance and to use evidence of student learning as a focus of the conversation and (b) to utilize the face-to-face PD to develop a common language for ESI so the cooperating teachers and their preservice mentees would have a shared framework to reference as they discussed a science lesson.

In written reflections prior to and after the PD, the cooperating teacher participants also noted personal growth in an end-of-module reflection on learning. The following is one mentor's initial ideas contrasted with her final reflection to the prompt, "Describe an effective mentoring conversation. What is the mentor doing?" The mentor's conception of her role during the conversation changed drastically as a result of the online mentor modules, as can be seen in the follow excerpt. When writing her initial ideas about mentoring prior to the modules, a mentor participant wrote,

In a mentor conversation, the mentor should be talking about strengths and weaknesses of the lesson/teaching. The mentor could be offering suggestions for ways to do things differently. The mentor should be providing plenty of praise for what the novice is doing well.

Before engaging with any content of the modules, the mentor thought her job in a conversation would be to point out strengths and weaknesses of the lesson and offer strategies to improve instruction, which are typical moves in the consulting stance. Then, after completing the modules, the mentor wrote,

In a mentor conversation, mentors should make sure to focus on student learning of the learning target and make sure to give lots of space for the novice to reflect on their instructional moves and student learning. Only give suggestions/ideas if the novice is not able to come up with it alone.

Following the modules, most mentors similarly noted that the conversation should focus on the targeted science idea rather than instructional moves, and that specific suggestions should only be provided if the novice is stuck regarding the next steps to support students' learning. Content and structure of the mentor conversations were intentional goals of the modules, and the initial ideas and reflections provide evidence that these goals were met.

Discussion and Implications

As the preceding analysis demonstrates, this model for hybridizing the PD by moving the mentoring strategies to an online format effectively supported the participants' mentoring practice and offered specific affordances not provided by traditional face-to-face teacher PD. Although cooperating teachers had classroom knowledge and valuable teaching experience upon entering our program, they more effectively coached the mentees and used evidence of student learning to guide their mentoring conversations with the novice teachers. Cooperating teachers who participated in the hybrid PD sequence showed statistically significant increases in their ability to use coaching as a default mentoring stance, to focus on evidence of students' science learning, and to draw on a consistent framework for ESI during their conversations.

The mentoring conversations after the PD series emphasized an exploration of student learning in relation to a science learning target instead of the stronger emphasis on student behaviors or management strategies prior to the PD. In addition, the cooperating teachers utilized a more flexible mentoring stance, coaching unless consulting was needed, which has been previously noted as an effective mentoring strategy (Lipton & Wellman, 2007). The online mentoring PD also provided a more time- and cost-efficient approach to PD while improving the mentors' ability to focus on what matters to support students' science learning (Clary et al., 2017; Fishman et al., 2013).

While the online mentor modules provided effective, flexible, and cost-effective training for helping cooperating teachers conceptualize and facilitate mentor conversations, the in-person ESI training provided necessary background information in terms of what cooperating teachers should look for and talk about in a mentor conversation. In order to focus the conversation on student learning, cooperating and preservice teachers needed to have a common understanding of the learning cycle within the science lesson and a common language to discuss that process.

Our in-person ESI PD provided a dynamic group learning environment and a shared experience to build community, which helped pinpoint individual teacher concerns and confusions and allowed us to focus on a specific framework for science instruction that preservice teachers were implementing. By combining the online mentor modules and an in-person ESI PD, the hybrid format resulted in effective PD for cooperating teachers mentoring novice science teachers.

Researchers have called for empirical evidence that demonstrates links between mentoring practice and novice teachers' learning and ability to support for students' learning (Berry, 2005; Cochran-Smith, 2005; Darling-Hammond, 2006; Goodwin et al., 2016; Jarvis, McKeon, Coates, & Vause, 2001). Effective mentoring strategies are also increasingly important for supervising teachers and teacher education programs, as the NGSS (NGSS Lead States, 2013) and EdTPA (Stanford Center for Assessment Learning and Equity, 2014) require mentor teachers to provide additional support to novice teachers. Our research efforts to develop and investigate innovative approaches to improve how mentor teachers support their preservice mentees have the potential to benefit researchers, mentor teachers, novice teachers, and teacher training programs.

Future Directions

Given the success of the online mentor modules in informing cooperating teachers' ideas about how to guide mentor conversations, a logical next step would be to move the ESI portion of the PD to an online platform. While the mentoring strategies reflected in the online modules are general enough to translate into an asynchronous learning platform, we are still working on developing domain-specific frameworks for ESI that could be transferred to an online environment. This could further alleviate costs associated with the hybrid PD model, while increasing accessibility to this portion of the training. However, we recognize the challenges in moving the science PD to an exclusively online platform.

As noted earlier, Moon et al (2014) identified three general tenets that have strong empirical support to guide development for teachers' PD, including that PD learning opportunities should be embedded in specific subject matter, involve active sense making and problem solving, and related to teachers' own problems of practice. With significant investment, the first tenet could be met by developing multiple online modules specific to subject domain frameworks and tailored to grade levels. However, the latter two tenets are challenging to satisfy via online PD.

Active sense making is generally a difficult process to scaffold through an online environment, due to the need for social interaction and the back-and-forth required when one is negotiating new understandings. Similarly, it is difficult to address teachers' own problems of practice without engaging participants in a live setting with support from their colleagues. Although we intentionally designed the ESI PD as a face-to-face experience, there is potential to move it online in the future. While we still "know little about how these web-enabled and social media capacities interact with teacher learning and whether or how they are in line with established ideas about professional learning in general" (Moon et al., 2014, p.175), we are beginning to investigate how we might create an interactive online delivery for professional development for ESI to accompany the online mentoring modules.

This exploration is particularly timely, as districts are moving to the more consistent framework for science learning offered by the NGSS (NGSS Lead States, 2013). Future research will investigate the potential to move the ESI portion of the PD to an online format to further share and promote ESI in concert with effective mentoring strategies.

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Appendix A
Science Lesson Observation Guide

Guiding Questions	Student Moves	Instructional Moves
Sense Making **<u>Did the elementary students:</u>** • connect what they did in the lesson to the targeted idea? • compare their emerging understanding of the targeted idea to their initial ideas? • compare their emerging understanding of the targeted idea to other science ideas they already know?		
Classroom Culture **<u>Did the practicum student:</u>** • encourage students to share their ideas and take intellectual risks? • encourage collegial interactions and working relationship among the students to accomplish instructional tasks?		

What evidence do you have about students' understanding of the targeted idea?
• What were the strengths or problematic aspects of students' thinking?
<u>Next Steps/Take-Aways:</u>

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