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Not-so-critical friends: Graduate student instructors and peer feedback

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Abstract

Graduate student instructors (henceforth, instructors) play a crucial role in teaching early STEM courses. Thus, professional development for these instructors addresses an urgent need to improve STEM student success. This paper focuses on a semester-long professional learning community in which six mathematics graduate student instructors engaged in regular cycles of peer observation, feedback, and reflection. In contrast to other professional development work, this approach emphasized that instructors give, not just receive, peer feedback. Analyses of post-semester interviews indicated that all instructors enhanced their noticing of students. The interviews also highlighted the challenges of providing critical, supportive feedback.

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Graduate student instructors (henceforth, instructors) play a crucial role in teaching early STEM courses. Thus, professional development for these instructors addresses an urgent need to improve STEM student success. This paper focuses on a semester-long professional learning community in which six mathematics graduate student instructors engaged in regular cycles of peer observation, feedback, and reflection. In contrast to other professional development work, this approach emphasized that instructors give, not just receive, peer feedback. Analyses of post-semester interviews indicated that all instructors enhanced their noticing of students. The interviews also highlighted the challenges of providing critical, supportive feedback.

INTRODUCTION

Introductory college calculus is a major barrier for students pursuing STEM careers in the US (Bressoud, Carlson, Mesa, & Rasmussen, 2013); low student success rates in calculus contribute to a lack of persistence, which has become an issue of national concern (PCAST, 2012). Fortunately, a growing body of evidence highlights the positive impact of student-centered teaching practices (Freeman et al., 2014), particularly in improving student persistence (Kogan & Laursen, 2014). Despite this evidence, college STEM classrooms are still dominated by instructor-centered teaching (Eagan, 2016; Lutzer, Rodi, Kirkman, & Maxwell, 2005). Thus, there is an urgent need to improve instruction in introductory STEM courses in the US.

Graduate student instructors play a crucial role in teaching introductory courses. As such, graduate student instructor support programs are now offered by 75% of PhD-granting institutions and 35% of Masters-granting institutions in the US (Ellis, Deshler, & Speer, 2016); of the institutions surveyed, 37% have a semester-long or year-long professional development offering. While such programs are growing in prevalence, they tend to be developed "in-house" by departments, and may or may not represent best practices for professional development. To address this need, there are now national efforts in the US that offer resources for professional development in higher education (e.g., Ellis et al., 2016). A cornerstone of the approach is to help graduate student instructors learn to implement student-centered teaching practices, particularly by learning to attend to and respond to student thinking (Franke, Carpenter, Levi, & Fennema, 2001; Sherin, Jacobs, & Philipp, 2011). Graduate student instructors are henceforth referred to simply as instructors for brevity.

To better understand how instructors learn to attend to student thinking, this paper explores how peer observations help instructors enhance their noticing of student thinking. In contrast to observations by faculty or more experienced graduate students (Miller, Brickman, & Oliver, 2014), peer observation supports noticing through giving, not just receiving, feedback. It also helps alleviate the costs of scaling and sustaining traditional methods of observations, which may create an undue burden on faculty members and more experienced instructors. In the present study, six mathematics graduate students met regularly in a professional learning community (henceforth community, for brevity; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006) and engaged in cycles of peer observation, feedback, and reflection through the community.

Analyses of post-semester interviews indicated that all six instructors felt more reflective about their teaching. Moreover, they described: the importance of being an objective observer, the impact of working with equal-status peers, and the challenges of providing critical feedback. The final issue, providing critical feedback, is explored in depth. Based on these results, this paper argues that peer observations provide benefits that extend beyond traditional observations of instructors.

THEORETICAL FRAMING

Enacting student-centered pedagogies requires instructors to build on the resources that students bring to the classroom. To build on these resources, instructors need to engage in three related processes: attending to, making sense of, and responding to student thinking (Jacobs, Lamb, & Philipp, 2010). The study of such decision making comprises the field of *teacher noticing* (Sherin et al., 2011). The goal of the present work was to help instructors enhance their noticing of students, rather than focusing primarily on themselves. Additionally, the paper focuses on other benefits and challenges associated with peer observations.

Communities can enhance noticing, as instructors reflect on teaching with peer support (van Es & Sherin, 2008). Effective communities are *communities of continuous inquiry and improvement,* with five features: (A) shared values and vision, (B) collective responsibility, (C) reflective professional inquiry, (D) collaboration, and (E) group, as well as individual, learning (Stoll et al., 2006). In this particular study, the community featured a system of peer observations, so that the instructors could support their peers as learners. This need not necessarily be a feature of communities in general.

Through its use of peer observation, the community gave instructors opportunities to provide feedback, not just receive it. Recognizing that not all feedback is equal (Hattie & Timperley, 2007), instructors were helped to provide critical, supportive feedback to their peers. When feedback focuses on *processes*, it is more likely to draw attention to student thinking, in contrast to feedback focused on *people*, which will draw attention to the

instructors themselves (Reinholz, 2015a). Person-focused feedback, such as praise, actually inhibits learning (Hattie & Timperley, 2007; Mueller & Dweck, 1998).

Providing feedback positions instructors as competent (Engle & Conant, 2002), and individuals may actually learn as much from providing feedback as receiving feedback (Reinholz, 2015c). Thus, conducting observations rather than just being observed provided instructors with opportunities for enhanced noticing. Moreover, each instructor was able to enter the classroom as a third party without the cognitive load of teaching, which allowed them to notice things in student behavior and thinking that they otherwise might miss. This paper adds to the study of noticing and instructor professional development by elaborating these opportunities. This paper addresses two main research questions: (1) how was instructor noticing impacted by peer observation? and (2) which features of peer observation supported or inhibited noticing?

METHOD
PARTICIPANTS
Six graduate students teaching either calculus 1 or 2 at a large research-intensive university participated in the study. The calculus classes were comprised of (each week): (a) three 50-minute lectures, (b) one 50-minute recitation, and (c) one optional 100-minute workgroup. The instructors each taught a combination of 3-4 recitations or workgroups. The recitations consisted of instructors: answering homework questions, completing examples, providing short worksheets, and administering quizzes. The workgroup sessions were collaborative problem solving sessions, modeled on the Emerging Scholars Program (Treisman, 1992). A key insight from the program was that providing students with additional challenge, rather than remediation, was a more effective way to support their success in calculus. The collaborative group work sessions were also designed to promote community and collaboration amongst the students.

The instructors in the study met as a community and conducted regular peer observations during a single semester. Instructors received no incentives for participation in the community; all four calculus 2 workgroup instructors participated as a part of the department's efforts to improve instruction, and two calculus 1 instructors were chosen by the department to participate. The demographics of the instructors were as follows: four women and two men, five domestic instructors and one international instructor, and the instructors had a variety of teaching backgrounds; the women were in their first year of teaching in the department, and the men had been teaching for a number of years. Two non-tenure track faculty in the department also participated in the community meetings.

DESIGN
Community Meetings. The community typically met every other week, for a total of seven one-hour sessions. The community was facilitated by a STEM education researcher, who shared videos, articles, and feedback on teaching with the instructors. The readings included articles (e.g., Reinhart, 2000) and book chapters (e.g.,

Hoffer, 2012) geared towards practitioners. Participants were also introduced to key ideas from K-12 mathematics education, such as groupworthy tasks (Featherstone et al., 2011), cognitive demand (Stein & Smith, 1998), and the 5 practices for orchestrating mathematical discussions (Stein, Engle, Smith, & Hughes, 2008). Participants were not required to complete the readings, and anecdotally, engagement varied between participants. The videos were taken from the canon of K-12 work, including Sean Numbers (Posner, 2008) and from the TIMSS studies (Stigler, Gallimore, & Hiebert, 2000). The facilitator also used classroom videos in undergraduate calculus from his own research. In addition, the feedback that the facilitator provided stemmed from his experience as a teacher and observation of other teachers.

The facilitator also assigned short "homework assignments," which required instructors to implement active learning strategies in their teaching. For instance, during the third meeting, the community discussed strategies for setting group norms. The facilitator modeled co-creating a chart on the board, in which instructors described "good group work" and "not-so-good group work." After the third meeting the instructors were tasked to try this strategy with their students, and debrief during the fourth community meeting. In debriefing, both Elayne and Tara described positive experiences with the activity,

> **Elayne**: At first [the students] thought it was kind of silly and were like seriously, we're in college, why are we doing this? But then after we made a list- I had them make the list just in their little groups, and then we came together as a class and made an overall class list, and that actually really helped. Just having it explicitly stated what the expectations were and what they wanted each other to be doing actually really helped. [Class sessions have] been better since I did that, so that was cool.
> **Facilitator**: That's awesome. Did anybody else play around with that kind of stuff?
> **Tara**: I did, and it was I think pretty successful. I feel a little more in control of my workgroup, which is good.

This activity reflects a general philosophy of the community; instructors were given basic, concrete teaching strategies to try out in their sessions, and given space to discuss and reflect on them during the community meetings. The goal of public reflections was to build community around using student-centered teaching practices. In general, collective reflection and community building were cornerstones of the community (Stoll et al., 2006). For example, during the first community meeting, instructors engaged in an activity similar to the one described above, in which they discussed their prior experiences as learners to develop a shared vision of good teaching (community principle A).

To support collective responsibility (principle B), reflective professional inquiry (principle C), and

collaboration (principle D), the facilitator refrained from providing "answers" to the instructors, instead promoting discussion. For instance, later in the same meeting described above, Edgar described a classroom management experience. In response, the facilitator directed the question to the rest of the group, and three members responded with their own experiences.

> **Edgar**: I had a classroom management thing that didn't work very well at all…four person group, and one student was kind of being know-it-all-y, and I was kind of like OK, how do I get the other people to talk? I was asking them to explain why geometric series converges for r less than one, and I said we're going to say two sentences one word at a time. It was the most dysfunctional thing that's ever happened…
> **Facilitator**: Do you guys have other thoughts what you might do in that situation?
> **Sabin**: If you have somebody who's kind of a know it all, or in general if somebody's always answering stuff, a good way to do it is to kind of get them to engage the other students. Say OK, explain this in detail, then try to get the other students to ask the detailed questions to that person so you can just start the conversation. Usually they'll start having a more balanced kind of conversation. Because at the end of the day it's OK that one of them's a little more dominant or a little bit more knowledgeable about it, but the idea would be to get them to have a back and forth. That's why I try to do…I'll play dumb [sic] and be like now wait a second, explain this little piece to me, so that the other students feel OK to ask those kind of small little details. That usually works.
> **Facilitator**: Do you guys have thoughts? What would you do? Just let them talk?
> **Elayne**: A lot of times I'll just ask do you guys agree with what this person said, even if it's right. Because a lot of times if you say do you guys agree, you're kind of hinting that it's wrong. But if you ask if they agree even when they're right, then sometimes they'll be like well I don't really get this part, or I'm not sure if I agree.
> **Tina**: Yeah, they do that a lot. I'll be like well how did you get that, and they'll be like now I know it's wrong. I'm like, it's not necessarily wrong.

In this conversation, Edgar begins with an experience of something that did not go so well for him. This indicates that he felt comfortable sharing his experiences with his peers. Rather than trying to provide an answer, the facilitator stepped back so the participants could speak with one another. Sabin provides some advice from his own experiences, suggesting that Edgar try to get the students to talk with each other. Elayne and Tina both discuss their experiences in facilitating those conversations, and techniques they used (asking is this right) to get students to talk with each other more.

Peer Observations. The instructors each completed 5-6 peer observations total, with three of their peers (two observations per peer). These observations were adapted from the Peer-Assisted Reflection cycle (Reinholz, 2015b). Each observation involved: (1) the instructor setting goals for the observation, (2) a peer observing and video recording the session, (3) a debrief conversation between the two instructors after they both observed each other, and (4) a whole-group debrief during the next meeting. The combination of peer-to-peer and collective debriefs was aimed to support both individual *and* group learning (community principle E). For instance, after their first observation, Tara shared her feedback with Leo,

> **Tara**: The main thing that I noticed with your recitation is there was this girl who kept asking questions to the [undergraduate assistant], which is fine, but then when you were trying to talk they were talking-
> **Leo**: Oh, yeah, yeah, yeah. At one point I did tell them that they'd go over it later.
> **Tara**: You did address it.
> **Leo**: We should use the [undergraduate assistant] section discussion to do some coaching.

In this conversation, Tara describes how she noticed the undergraduate assistant was talking with students at the same time that Leo was trying to talk to the class as a whole. Leo recognized this is an issue that they should talk with the undergraduate assistants about as a whole group. In this way, observations between peers brought insights that could impact all of the instructors.

Observations were facilitated by peer feedback forms. The observed instructor began by listing their goals for what they wanted a peer to pay attention to. Then the peer provided specific examples to answer three questions: (1) What opportunities did students have to talk about mathematics?; (2) What opportunities did students have to work with other students?; and (3) What else did you notice, both related to the instructor's goals and otherwise? These forms were used as the basis for the peer conversations described above.

DATA SOURCES AND ANALYSIS
Pre- and post-interviews were conducted with the instructors. In addition, all group meetings were audio recorded, and peer observation forms were copied. These data sources were used to inform the post-interview protocols, and were also used to check for consistency between what instructors reported throughout the semester in the community meetings and what they described in their interviews. The pre-interviews provided

context and background on the instructors; the post-interviews were used as the basis for the analyses that follow. The post-interviews focused on the following areas: teaching philosophy, Peer-Assisted Reflection, experiences exchanging feedback, and beliefs about feedback. The goal of the interviews was to holistically understand how the instructors experienced exchanging peer feedback, including: how they felt, what they learned, and what challenges they encountered.

All interviews were transcribed and coded by the researcher. The goal of coding was to understand how instructor noticing was impacted by peer observation. Drawing from techniques in grounded theory (Glaser & Strauss, 1967), a first pass of coding was conducted to identify emergent themes. These themes were: (1) objective observers, (2) equal-status peers, and (3) critical friends. Once these themes were identified, the researcher completed a second pass of coding to look for the prevalence of themes across the six post-interviews. The presentation of results that follows is illustrative, intended to highlight important areas for future research. All names below are pseudonyms.

RESULTS
OBJECTIVE OBSERVERS

All six instructors discussed becoming more reflective about their teaching and improving their noticing of student thinking. For example, Leo contrasted his years of prior experience with his engagement in the community,

> I didn't really think that much about teaching. I would sort of hope my students did well on the tests and give me good [ratings], but thinking about the process is something that I've really gotten out of this, and to really try to empathize a little and put yourself in the students' shoes and ask what is this teacher doing, or what should this teacher be doing.

Leo describes that teaching was something he did for many years, but "didn't really think that much about." In contrast, the community provided Leo with time and space to reflect on his teaching, learning to put himself in "students' shoes." Leo described the importance of observations, which allowed him to be in a classroom unburdened with the responsibilities of teaching,

> Well when you're not constantly running around helping people with math, it's really easy to tell when groups have sort of lost focus. You also get a better feeling for, I think, the dynamic between people, seeing how certain groups view their teacher…

In other words, peer observations supported Leo to improve his noticing of students, because they provided him with an opportunity to focus *only* on students, rather than all of the other responsibilities associated with teaching. Similarly, Tina described enhanced noticing resulting from being an observer,

I was able to pay more attention to students' interactions in other workgroups. I guess I learned something about how the students interacted…I feel like there were the different groups. There was the group that had a ringleader that would get everyone going and would lead everything, and then there were some groups that would just not be working, and then there were groups that would be working pretty well together.

Peer observations also allowed the instructors to compare the different types of classroom environments that their peers created holistically. For instance, Celeste reported on insights developed by comparing three different peer classrooms,

> I knew that I have some problems with my recitations, I knew that I'm not as good as I should be. And observing Tina and Tara and Elayne I saw, OK, this one's not working so probably I should not do it, and this one is working.

Celeste describes noticing what was "working" and "not working" in her peers' classrooms, which informed what she herself would do as a teacher. In this way, observing her peers help Celeste become more aware of things that she would attend to in her own classroom. Moreover, observing multiple peers helped her see gradations in quality of teaching practices, which is a key aspect of identifying a high-quality performance (Sadler, 1989).

The observations also provided instructors with concrete instances of student-centered teaching. For example, Elayne emphasized the value of watching Edgar teach, who focused on "guiding students" rather than just "giving them the answer,"

> Well I learned a lot about just the whole guiding students to the answer instead of giving them the answer, just watching other people-like I keep bringing up Edgar, because I think he was one of my favorite people to observe because he would literally just ask questions the whole time and not give any answers.

Elayne further described how such observations changed her views on teaching,

> A big role that I found this semester was just learning to ask the right questions and having patience… if the student is able to get to the answer on their own instead of you just giving them the answer, it builds their confidence and they retain it longer. Even though it might take three times as long for the student to get there instead of you just showing it to them, in the end they're going to do better in the class and be able to learn the math better if you allow them to get to it eventually.

As the above interview excerpts highlight, observing their peers provided opportunities for the instructors to notice new things in the classroom and helped shift their attention away from themselves towards students. Although changes in instructor teaching practices were not analyzed, prior research showed that working with instructors in the same department in a similar setting resulted in measurable changes in practices (Reinholz, Cox, & Croke, 2015).

EQUAL-STATUS PEERS
An important feature of the community was that the instructors observed peers of relatively equal status. This contrasts approaches that focus on "experts" (experienced graduate students or faculty members) observing or being observed by "novices" (new instructors). This allowed the instructors to form community with their peers. As Leo noted, the community helped him shift from competition to collaboration,

> I really liked our group meetings where we sort of realized we're all in the same fight. Sometimes there's a little bit of competition, at least in my mind, between [instructors], because you really want to have good [student ratings] and that's sort of only measured relative to a baseline. So you're like I want to be the best, I want my students to love me the most. But really more interesting are these questions of how do we prepare our students, all of our students, the best, and how do we teach the best. It was good to have actual regular meetings with other teachers in a way that…I don't know. It was a good emphasis on pedagogy, reminding myself why I'm actually there. It's not to get high scores, it's to teach kids math.

The instructors also discussed the culture of mathematics and the pressure to understand all of the mathematics that they were teaching at a deep level. When the instructors observed their peers and realized that their peers also found aspects of the mathematics challenging, it was reassuring for them. Even Edgar, who was a relatively experienced instructor, noted that the peer observations helped him overcome aspects of his imposter syndrome (feeling as though he was not skilled enough to be an instructor),

> [T]hey're also not crazy experts with the material. In learning that I felt more comfortable…There were instances where I was like I know how sequences and series work, and then I'd try and teach somebody how sequences and series work and I'd be like ah, fair enough, I don't know how sequences and series work…just seeing that [other instructors] were also struggling with that is reassuring, that I shouldn't feel the imposter syndrome or anything like that.

Edgar's comments speak to broader cultural issues around mathematics, in which mathematics is often equated with intelligence (Nasir & Shah, 2011) and there is great pressure for the instructors to act as authorities in the discipline. In observing Tina, Edgar noticed that she would often look at the solutions to problems during in the middle of workgroup sessions, and he felt that it was all right for him to do the same thing,

> So I was like, OK. I've always kept the solutions in my back pocket, so then it feels weird to, like, here are the solutions right in front of the group. Leaving and saying work on this and then refreshing privately, so to speak, so you maintain the aura of knowledge.

Here Edgar describes a concrete strategy, leaving and looking at answers away from the group, that allowed him to maintain what he perceived as his necessary authority as an instructor, while "refreshing" his understanding of the mathematics.

The idea of an "aura of knowledge" relates to narratives tying mathematics and intelligence (Nasir & Shah, 2011) and the perception of authority that instructors felt that they had to maintain. Related to these narratives, Tara expressed anxiety in being observed,

> I mean sometimes the students would ask really hard questions and I wasn't completely sure of the answer, so I was worried that I'd be judged for being stupid by the other [instructor] basically.

As Tara expressed, the instructors felt pressure to be experts. Addressing this anxiety has potential to support instructors through peer observation and in instructor development more generally. It also relates to how comfortable instructors felt providing critical feedback to each other.

CRITICAL FRIENDS
All six instructors stated that they found critical feedback to be more helpful than praise. For instance, Celeste discussed how overly positive feedback did not support her learning,

> Tina and Tara…they were always happy with the things that I wanted them to look at and I don't think that's very accurate…I think they wanted to be encouraging, like keep doing that, it's good. But I kind of liked Elayne's [feedback] the best because she actually provided actual things that I have to improve.

Celeste remarks that she did not necessarily trust overly positive feedback, because she knew she had room to grow as a learner. Moreover, she was able to contrast this with Elayne's constructive criticism, which helped her grow as an instructor. Upon receiving this not-so-helpful feedback, Celeste recognized that when she provided the same types of feedback to her peers it must also not be so

helpful for them. As such, she altered the feedback she provided to peers to be more critical,

> I know that at the beginning I was like everything's great, nice, you're doing good. So I did that, and I know I did it. I didn't know them or what they would think, how they would react, would they get angry, so I wanted to be positive. But after Elayne I understood that's not the point. I knew when we talked that that's not the point, but it's different when you actually experience it. After that I tried to be more critical.

Celeste describes the initial barrier to providing critical feedback; she did not want to hurt the feelings of her peers or be judged by them. Yet, as she received critical feedback from Elayne, she realized that this was an important part of supporting her peers to grow, and changed her feedback accordingly. Edgar similarly described critical feedback as supportive,

> It's kind of like if I have to write a cover letter for my next job application and I hand it to my good friend Joe, and Joe says this is awesome, well done, I think you're going to get the job, you're a cool person, I would hire you. I'm like thanks Joe, you're nice. And then I give it to my good friend Stephanie – and I don't have any friends named Joe or Stephanie, these are made up names – and she says well, you know, it's passable. I've seen cover letters like this, I've written cover letters like this. It's good, but you could do better. There's this and this. I write like this, so when I read your handwriting doesn't make any sense to me. Take it or leave it, because when people read my handwriting they say the same thing to me. Tonal choices. This whole paragraph, what does it mean? It doesn't mean anything, I didn't get anything from it. What were you saying with that paragraph? It's like thanks Stephanie, I feel like I'm going to get the job now because I'm going to get rid of that paragraph and write something useful.

Here Edgar contrasts being "nice" with being "supportive." Edgar describes two imaginary friends, Joe and Stephanie giving him feedback on a cover letter. Joe is *nice* because he provides encouragement, but Stephanie is *supportive* because she provides critical feedback that can be used as fodder for improvement. In this professional context, Edgar emphasizes that support is more useful than niceness as it will actually help him get a job.

Despite general recognition that critical feedback was more useful, two of the instructors struggled to give critical feedback, and were overly positive. As Tara said,

> Like there was one particular [instructor] who I think really needs to talk more and give more direction to her recitation, but it's sort of hard to give that advice because of her situation. I

didn't really know what to say to her… I guess I don't really feel comfortable giving negative feedback to someone's face.

When Tara describes the instructor's "situation," she is likely referring to her being an international student and nonnative English speaker. Given these circumstances, Tara tried to protect her by not giving her critical feedback, but in the end was also limiting her opportunities for growth. This relates to the mentor's dilemma, in which individuals may withhold critical feedback because they do not want to undermine someone's confidence (Cohen, Steele, & Ross, 1999).

Not only did Tara withhold critical feedback, her reticence to criticize others made her doubt the feedback that she received from peers,

> I didn't really feel like I learned as much from the feedback as I did from observing other people teach. I don't feel like I learned a whole lot from the feedback. Well, maybe it's because I just don't really trust- I guess maybe because I don't give totally honest feedback to people I don't trust them to do the same for me, so they can give me feedback but I don't think that I'm getting the real picture anyway. So I'd rather just watch other people and try to learn from that.

Tara said that she could not trust the feedback others give her, because she knows that the feedback she herself gives is not "totally honest." As such, she saw all of the feedback she received as filtered, not showing her the "real picture" of her teaching. When asked what messages were conveyed by the feedback that were not totally honest, Tara said,

> That I'm doing a great job and there are minor details that I should fix. Maybe that's right, but you know. I guess maybe I would want someone to be brutally honest with me, but I can understand how- Like, I wouldn't want to be brutally honest with anyone else, so that's a hard thing to do.

Tara describes receiving feedback that only focuses on minor issues in her teaching rather than feedback that would help her address major issues that need improvement. Tara highlights a tension here: she wants others to be "brutally honest" with their feedback, but finds it difficult to do the same for her peers. Like Tara, Tina described tempering her feedback to her peers,

> I tried to be honest, but it's sort of how you phrase it, right? When you think something's horrible you don't want to just be like this is so terrible. You try to phrase it in a nice way…I'd probably try to blame it on the students instead of the teacher. So then I don't feel like I'm directly criticizing the teacher.

Rather than being "honest," Tina talks about phrasing things "in a nice way," which shifts the locus of control to students rather than the teacher. This tempering of feedback likely relates to Celeste's perception that Tina was overly positive, which made her feedback less useful. When asked about whether or not she acted as a critical friend for her peers, Tina said,

> I was probably less critical…Because I don't like being mean.

While Edgar contrasted being nice (not supportive) with being critical (supportive), Tina equated being critical with being mean, which she perceived as negative. As such, there appeared to be a divide between the instructors in how they perceived criticism; both Edgar and Celeste saw it as a way to help their peers, whereas Tara and Tina were concerned with providing what they perceived as negative feedback to their peers. When the interviewer followed up on what she meant by "mean," Tina said,

> It's not being mean. Maybe it feels like it, but it's not…It sounds silly when I say that.

Tina's response indicates that she herself had not completely worked out her understanding of the differences between being critical and being mean. Nevertheless, this response highlights that Tina was dealing with a number of tensions and contradictions in her conceptualization of critical feedback. Elaborating on barriers to providing such feedback, Tina said,

> I guess being friends is kind of a barrier because if someone is your friend you don't want to hurt their feelings. I think another barrier is feeling like, well, if I give them maybe more critical feedback, maybe I'm being a know-it-all, and I don't know everything about teaching, so am I justified in giving this very critical feedback…

Here Tina describes not wanting to hurt the feelings of her friends. Thus, while for Edgar and Celeste supporting their peers was the most important aspect of providing critical feedback, for Tina, fear of hurting her peers' feelings was a barrier that prevented her from providing such feedback. An additional complication in providing critical feedback relates to familiarity with peers; Celeste became more comfortable as she got to know her peers more, while Tina actually noted that being too comfortable could be an issue.

Finally, Tina brought up the issue of authority, and whether or not she was actually justified in providing criticism. In contrast to Tara, Tina talked about "not wanting to hear" critical feedback,

> [I]t's hard to give feedback that you wouldn't want to hear. Maybe you'd be giving feedback that you're not perfect at either, so you don't want to come across as like I know everything about teaching. So you kind of have to recognize that you don't know everything

about teaching and this person doesn't either, but maybe you can help them get better…I want to get better at teaching, and I want feedback, but it's hard to hear people tell you things you're doing wrong.

Tina classifies critical feedback as describing "things you're doing wrong." This framing contrasts Edgar's description of useful feedback providing room for improvement. Stephanie, Edgar's imaginary friend, told him that his cover letter was "good, but you could do better." It could be that instructors' perceptions of the meaning and purpose of critical feedback may support or inhibit them to provide peers with critical feedback. There was some evidence in support of this hypothesis in how Elayne described her learning from peer feedback,

> With Edgar observing me I got really good feedback about these are some strategies I've picked up as a teacher that could help you, and that was really helpful. Leo was really helpful in seeing how I could use my [Learning Assistants] better and pointing out ways that could be more productive…[Celeste] was able to say, you know, maybe you should walk around the classroom more and really use the space more within the classroom, which is when I was like, OK, maybe I'll start making worksheets. It was positive, helpful feedback. It didn't ever make me feel bad about my teaching or anything.

Elayne describes all three of her peer observers providing "positive, helpful feedback," even though all observers described areas that could use improvement. Elayne's view is consistent with the feedback she provided to Celeste, who described it as critical and helpful.

DISCUSSION

Peer observation can enhance noticing, helping instructors focus more on what students are doing rather than on themselves. In particular, when instructors are positioned as competent to provide meaningful feedback, they can learn through observing others and form meaningful community with equal-status peers. As such, equal-status peer observation can improve professional development. For instance, they are a low-cost alternative to observations conducted by faculty or experienced peers, because the very process of observing instructors becomes a learning experience for the observer rather than a "cost" for the observer in service of another instructor's learning. Moreover, it gives instructors an opportunity to interact with students in a different capacity, increasing their understanding of their students.

How instructors engage with peer feedback is a complicated process. In the US, mathematical ability is often taken as a sign of innate intelligence. Similarly, there are widespread perceptions that teachers are "born, not made." Given these beliefs, instructors may feel uncomfortable being observed by their peers, because they do not wish to show any weakness in their mathematical understanding or skills as teachers. Similarly,

instructors may hesitate to provide critical feedback, because they want to be kind to their peers. Thus, to create a productive community of equal-status peers it is critical to address perceptions about math and intelligence and create a culture of lifelong learning. Barriers to productive exchange may be different in other cultural and disciplinary contexts, but nevertheless, the nature of a given discipline must be given attention.

A key aspect of a productive learning culture is how instructors view critical feedback. If instructors view critical feedback as Edgar did, as a means to support growth and improvement, they are more likely to provide such feedback to their peers. In contrast, if instructors view critical feedback as "mean," like Tina, they will be much less likely to do so. As such, a productive culture for mutual growth requires normalizing failure, so that instructors can view themselves as lifelong learners who are always improving, rather than as lacking in their abilities. This connects to creating a growth mindset for the instructors. If instructors see themselves as capable of improving through effort and struggle, they will be more likely to interpret the criticism they receive as a tool for growth, rather than as a sign that something is deficient with them.

Beyond instructor support, the findings of this paper can also speak to other learning arrangements in which individuals are supporting their peers, like peer tutoring (Colvin, 2015) or near-peer mentoring (e.g., Crisp & Cruz, 2009; Zaniewski & Reinholz, 2016). In such situations, the benefits of providing feedback to one's peers still apply, and at the same time, there are potential pitfalls related to providing critical feedback. Work on the mentor's dilemma in interracial mentorship (Cohen et al., 1999) may provide potential solutions for helping students provide critical feedback. In particular, the mentor's dilemma is resolved through the combination of high standards and high support. A culture that embodies these values may help instructors provide critical supportive feedback to each other. Yet, in the graduate student context there is the additional complication that instructors do not necessarily perceive themselves as experts capable of providing "high support." As such, a community leader may have an important role to play in creating a culture of high expectations and high support. Fortunately, there is a vast literature on supporting learning through feedback and mentorship. Educating instructors around such studies may help influence their perceptions of feedback and support them to provide critical feedback to one another. These are areas for future research.

While this paper focused on mathematics instructors, the insights are likely to apply to instructors in other disciplines, especially in STEM. Physics, chemistry, and many other "hard sciences" are also perceived as signs of innate intelligence, so peer observations may help combat the imposter syndrome. Given the culture of these disciplines, providing critical feedback may once again be an issue. Beyond STEM, the general benefits to seeing peers and enhanced noticing could likely be experienced in most disciplines. More than just a cheaper alternative to "expert" observations, peer observations support instructors to learn through giving, not just receiving, feedback. This provides them a new vantage point on classroom learning, and also positions them as competent contributors to the learning of their peers.

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