"*We Became the Kids in the Classroom*!"- Promoting Responsive Teaching through Cultivating Teachers' Epistemic Empathy

Abstract

This work examines one aspect of how engaging teachers in doing science in responsive ways translates into responsive instructional practices. We draw on data from a year-long blended-online science professional development (PD) program designed to engage teachers in doing science and connect those experiences to their teaching. Using classroom videos, we found that over time teachers more stably took up students' contributions as scientific and built on them responsively during instruction. Moreover, our analysis shows that teachers drew on their own *intellectual and emotional* experiences of doing science in the PD to connect to their students. Engaging in science inquiry, we argue, provided a basis for cultivating teachers' *epistemic empathy*—their capacity for tuning into their students' intellectual and emotional experiences—that helped stabilize teachers' attention to students' work, explaining in part their progress towards responsive teaching.

Keywords: Scientific Inquiry; Science Teaching; Teacher Professional Development; Responsive Teaching; Epistemic Empathy.

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Purpose

Research in science education is increasingly focused on student disciplinary engagement in science (e.g., Engle & Conant, 2002; Ford, 2008; NRC, 2012). For teachers to foster such engagement in their students, they need to have some understanding of the practices of science themselves. As such, teachers need professional development (PD) opportunities to experience science as an *epistemic pursuit* where they construct, assess, and refine ideas over time (Moon, et al, 2012; van Zee & Roberts, 2001).

It is widely accepted that engaging teachers in science supports their conceptual understanding and their familiarity with science as an intellectual pursuit. Our purpose here is to argue that, in addition to conceptual and epistemological affordances to engaging teachers in science, affective aspects of teachers' experiences may also contribute to their understanding of science; those cognitive and affective affordances, then, help teachers tune into and appreciate their own students' epistemic experiences in the classroom.

We draw on data from a year-long science PD designed to engage teachers in extended inquiry and connect those experiences to their teaching. Throughout the PD, we noticed a shift in teachers' instruction specifically in their attention to and pursuit of students' contributions. Here, we ask: *How did the teachers' instruction shift throughout the PD? And what supported this shift?* We argue that having firsthand experiences with the cognitive and affective work of science fostered teachers' epistemic empathy—the capacity for tuning into and appreciating someone's cognitive and affective experiences within an epistemic activity. Such empathy, we argue, promoted teachers' attunement and responsiveness to students' experiences in the classroom.

Theoretical Background

Responsive teaching

Reform efforts emphasize the importance of fostering student sense-making and epistemic agency in science classrooms (NRC, 2012). *Responsive teaching*, which centers on attending to, eliciting, and responding to student thinking, holds great promise for realizing this vision (Richards & Robertson, 2016). Rather than focusing on the established body of canonical knowledge as the exclusive goal, responsive teaching starts from and privileges student reasoning, while cultivating disciplinary practices of learning.

Viewing learners as having a rich array of resources to explore, interrogate, and understand the world, responsive teachers make space for and elevate students' experiences, ideas, and curiosities (Duckworth, 2001; Maskiewicz & Winters, 2012; Rosebery, Warren, & Tucker- Raymond, 2016; Windschitl, Thompson, Braaten, & Stroupe, 2012). Instead of evaluating them for alignment with the canon, teachers seek out the disciplinary roots in those experiences, ideas, and curiosities and build on the scientific beginnings in students' thinking and practices (Ball, 1993; Robertson & Richards, 2016; Russ et al., 2009). Responsive teaching, then, grounds instruction in those beginnings in ways that honor student thinking and support them to make progress along disciplinary lines (Robertson & Richards, 2016).

Research indeed shows that responsive teaching can support disciplinary learning. For example, studies have shown that responsive teaching promotes students' conceptual gains and disciplinary practices (e.g., Coffey et al., 2011; Colley & Windschitl, 2016; Pierson, 2008; Radoff et al., 2018; Thompson et al., 2016). Moreover, by expecting value in student thinking

and everyday experiences for scientific understanding, responsive teaching presumes that *all* students are capable meaning-makers (Robertson et al, 2016; Rosebery et al., 2016). Lastly, by centering instruction around student ideas and questions, responsive teachers open up curricula and classrooms in ways that position students as epistemic agents responsible for constructing, communicating, and assessing ideas (Duckworth, 2001; Ko & Krist, 2019; Ford, 2008; Scardamalia, 2002; Scardamalia & Bereiter, 2014; Sikorski, 2016). As such, responsive teaching promotes disciplinary learning and engagement by "bring[ing] students closer to the heart of what it means to do science" (Robertson & Richards, 2017, p. 317).

However, despite the growing attention to responsive teaching, there is yet much to be learned about the underlying dynamics behind responsiveness, and how to prepare teachers to become responsive (Kang & Anderson, 2015). We argue that "epistemic empathy", which we discuss below, is a key factor in responsive teaching.

Epistemic empathy

Empathy has been studied in many fields, including philosophy, neuroscience, psychology, and cognitive science (e.g., Batson, 2009; Eisenberg, 2000; Rameson & Lieberman 2009). While there is no consensus on the nature of empathy and its development, most studies describe empathy as "tuning-into" someone's experience (Oxley, 2011) to project into their situation and value their thoughts, feelings, intentions, and actions.

In education, scholars have discussed the importance of teachers' empathy in promoting socio-emotional learning, reducing aggression, and fostering a sense of belonging (e.g., Arghode, Yalvac, & Liew, 2013; Cassidy & Bates, 2005). Those accounts have looked at teachers' empathy with respect to students' families and cultural backgrounds, interpersonal relationships, and other life circumstances that may affect students (e.g., Dolby, 2012; Tettegah & Anderson, 2007; Warren, 2018). Such considerations, research shows, are essential for teaching.

Here we discuss teachers' empathy as *epistemic* (Author, 2018), that is, in relation to students' experiences of constructing, communicating, and critiquing knowledge (Barzilai & Chinn, 2017; Chinn, Rinehart, & Buckland, 2014; Ford, 2008), to distinguish it from prior accounts of empathy in the teacher education literature—what some scholars have referred to as *cultural* empathy (Dunn & Wallace, 2004; Pedersen, Crethar, & Carlson, 2008). With its emphasis on epistemic dimensions, epistemic empathy, we argue, is particularly important for theorizing and understanding teacher learning with respect to *responsive* teaching. Epistemic empathy provides teachers a window into students' sense-making and their ways of reasoning and feeling as they explore phenomena, and as such, may account for how teachers come to be responsive to students' *epistemic* experiences in the classroom.

Method

This qualitative exploratory study is in the context of a three-course science PD for upper elementary and middle school teachers. The PD engaged teachers in extended science inquiry, relying heavily on participants' questions, their efforts to generate explanations, and their work to design experiments to test out their explanations. While the first course was mostly about teachers' own inquiry, the second course also had teachers study examples of student inquiry, and the third focused primarily on teachers' analyses of their classroom videos which they collected throughout the PD. Eight teachers completed all three courses, meeting in-person once per month as a large group with the PD facilitators, and interacting online for the rest of the time in a discussion-board learning environment. The primary source of data for this study consisted

of the videos from participating teachers' classrooms, which included four videos per semester for each teacher (totaling 12 videos per teacher and 48 videos for all eight participating teachers). We also draw on interview data where teachers reflected on their experiences doing science and how that shaped their views on teaching science and their instructional practices.

We focused the first part of our analysis on five minute-clips (from minutes 2 to 7) from participating teachers' classroom videos (Derry et al., 2010). Using a constructivist grounded approach to the analysis (Charmaz, 2006), we examined whether and how the teachers oriented to and took up students' ideas as scientific; more specifically, we focused on instances that show evidence of the teacher engaging as a sense-maker with the students—noticing the substance of student thinking *and* working with that substance. In other words, we coded instances where the teachers not only noticed, but also pursued students' ideas, regardless of their alignment with the canon. We also tagged instances where students explicitly made references to and connections across each other's ideas (including to challenge, build on, or refine ideas), which we took as a reflection of classroom norms around attention and responsiveness to ideas, or as evidence of students' orientation to each other's ideas.

Second, we analyzed teachers' interviews to identify themes (Braun & Clarke, 2006) that depict whether and how they experienced their scientific engagement during the PD as consequential to their science instruction. In particular, we identified instances where the teachers noted benefits to *teaching* science in the way they *experienced* science in the PD, as well as instances where they discussed the challenges in teaching science in a similar way (as a pursuit of coherent understanding). The first and second authors analyzed the video and interview data separately and met on a regular basis to discuss their analyses, resolve disagreements, and as a result refine their interpretations and understandings of the data.

Third, in order to understand at a finer-grain size *how* the doing of science related to teachers' classroom practice, we developed in-depth case studies of teachers' scientific engagement in the PD and of their instruction. We developed detailed narratives of teacher learning that helped us understand trajectories of teacher growth with respect to teaching science as an epistemic pursuit instead of merely as a body of information to be delivered.

Findings

Progress towards responsive teaching

By analyzing videos from teachers' classrooms, we found that, over time, teachers more stably took up students' contributions as scientific and built on them responsively in their instruction. As illustrated in figures 1 and 2, there was a clear shift in teachers' instructional practices over the three-course PD. Figure 1 shows a collective change in the number of coded instances across all participating teachers; Figure 2 shows the coded instances for each teacher in each course.

These findings were corroborated with evidence from teachers' own reflections on their teaching. In their interviews and final papers, all teachers described a shift in their instruction, moving away from following scripted lessons to privileging student sense-making and engagement in inquiry. Teachers also noted developing facility with listening and responding to student thinking to orchestrate productive discussions. Additionally, teachers discussed a shift in their classroom dynamics and in their goals for their students, especially in terms of students taking up more agentive roles in constructing and critiquing ideas. Table 2 includes representative quotes from teachers' reflections that illustrate these claims.

Epistemic empathy as a driver for responsive teaching

To understand what supported teachers' progress towards responsiveness, we examined teacher interviews and final papers for aspects of the PD experiences that the teachers identified as particularly powerful for their learning. Our analysis shows that the teachers drew on their experiences doing science as a way to connect to their students' experiences and foster students' epistemic work. Through experiencing firsthand the practices, drives, and feelings of the discipline, teachers came to relate their own science experiences with those of their students. More specifically, teachers noted how being placed in a learner's position in a responsive science PD environment helped them understand and appreciate the intellectual and emotional work of science, which in turn supported them to become more tuned to their own students' thoughts and emotions in the classroom. Gabriel expressed this idea by noting how doing science in the PD shaped his new goals for his students:

> The excitement I felt when I was close to figuring out why helium balloons go backwards in a breaking car, the feeling of predicting the rainbow experiment's results, and the lesson I learned when I realized I had "driven right past" a fundamental idea with the denser salt water being a heat transfer inhibitor are all moments I recall vividly." [...] If I can get my students to have experiences similar to these that stick with them, then they will have had a very worthwhile 7th grade science year.

Like Gabriel, Jessica connected her own PD science experiences to those of her students, which helped her make sense of their initial resistance to her new instructional approach:

> It took some time to get [my students] to let go of the expectation that we have to have a final answer, that I'm going to tell them what it is [...] even for us as *teachers* taking the course for the first several weeks, we struggled with that […] As I reflect now, I think they were just going through the first phase I went through, of not really knowing "what it is that you want from me. I already told you what I think, why are you still pushing and asking me to explain more?"

Rachel relayed a similar sentiment reflecting back on her students' discomfort sharing their ideas, noting that the students may have had "the same kind of issues" that she and her peers experienced early on in the PD where they wanted the instructor to "just tell them things."

Other teachers commented on how experiencing feelings in science— from trepidation to excitement, from frustration to enjoyment, from vulnerability to motivation— was equally important for fostering their empathy for students, and in turn for supporting their students' own navigation of epistemic feelings in the classroom.

Dione, for instance, openly discussed her feelings of insecurity at the beginning of the PD, and how those feelings positioned her to better understand her students:

> The first class, everybody was like, "I don't understand what we're supposed to be doing here." [...] but it gave us an idea of how the kids- well at first we were all like, "Well I'm not writing that. I feel stupid if I write that." And [the PD facilitators'] point was, "that's how the kids feel." So it was kind of learning through empathy how to do it and then being able to transfer that to the kids and teach them that it's okay to think that way. […] And how [the facilitators] explained it was, "You might feel like that kid who's afraid to raise their hand because they think their answer is wrong." So… they transformed our thinking into the thinking of the kids. Because in essence that's what we were… we became the kids in the classroom.

In her final reflection, Dione explained that "by being dropped into the middle of what our students feel" provided her with "a unique perspective." She reflected on how participating in

extended inquiry centered on hers and her peers' thinking "tuned [her] in" to her own students by allowing her to take *their* perspectives and to gain insight into what *they* may be experiencing.

In sum, through first-hand experiences with science and the associated feelings of vulnerability, frustration, and excitement, teachers gained a deeper perspective on and ability to connect with their students' epistemic experiences. Engaging in extended scientific inquiry, we argue, provided a basis for cultivating teachers' epistemic empathy—their capacity for tuning into their students' cognitive and emotional experiences—which served to stabilize teachers' attention to student disciplinary work, explaining in part their progress towards responsiveness.

Conclusion and Implications

Given the limited studies that examine how teachers come to be responsive, this work contributes to the literature in at least two ways. First, the analysis provides an empirical account of teachers' progress in responsive teaching, tracing the impact of a PD centered on teachers' extended inquiry back into the classroom. Such an account is particularly useful given the scarcity of empirical studies that document how doing science within a PD setting may percolate into and shape teachers' instructional practices. Second, the study draws attention to the relationship between teachers' *doing* science and *teaching* science, in particular in terms of cultivating teachers' epistemic empathy to support their responsiveness. More specifically, our study shows that teachers' doing science, where they attend closely to and pursue each other's thinking, can help them recognize the work involved in attending to and pursuing student thinking in the classroom. Through experiencing the practices, drives, and feelings of the discipline, teachers connected their own intellectual and emotional experiences in science with those of their students. As such, teachers gained a deeper perspective on and capacity for tuning into their students' epistemic experiences. Such epistemic empathy, in turn, helped teachers frame their work of teaching as about paying close attention and carefully responding to student thinking in ways that position students as the intellectual agents in the classroom.

While limited to a single case, our work therefore offers new understandings regarding *how* teachers come to enact responsive practices in the classroom by highlighting epistemic empathy as a driver for responsive teaching. In these ways, the study motivates further attention within teacher education and PD programs to target epistemic empathy as a learning goal for teachers. One way in which this can happen, as we saw in this study, is by engaging teachers in doing science in responsive learning environments. Further research is needed to examine other educative opportunities that could foster teachers' epistemic empathy, and in turn, their responsiveness in the classroom.

Lastly, while this study suggests the importance of teachers' empathy for students' sense-making experiences, it also raises important questions regarding potential pitfalls of epistemic empathy. In particular, we wonder: Might one be more likely to empathize with people who look and sound like them, such as for example people of the same cultural, racial, or linguistic background? Might in turn such empathy position certain students in more or less advantaged situations regarding the knowledge construction process in the classroom? If so, how might one cultivate cultural empathy in service of epistemic empathy, in order to mitigate such differential epistemic positioning of students? These questions warrant further attention to potential tensions and synergies between epistemic empathy and cultural empathy, considerations that may have important implications for equitable instruction and social justice. Bearing heavily on matters of equity, these questions are important to pursue if the field is to move towards more equitable responsive teaching for *all* students.

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Appendix 2: Tables and Figures

Table 1

Coding scheme for instances of teachers' orienting to students' ideas as scientific.

Codes	Examples
1. Revoicing an idea with interpretation (instead of simply repeating students' words).	So, your thought is that, and correct me if I'm wrong, there's oxygen down here because the balloon is filled with helium. Helium is lighter than oxygen, and it allows the balloon to rise because the oxygen is heavier so it goes below it?
2. Expanding the substance of student ideas, such as by bringing in an example to illustrate an idea or seeking and providing evidence to support it.	Why does the water in the cup- we know that sunshine heats it up, but how does it go from water in the cup? Like I heat- I heat up my coffee every morning and the coffee is still in the cup. It's, it's not all gone.
3. Probing with reference to specific student ideas (and not necessarily for the purpose of leading to canon).	if you don't mind I'm gonna push you a little bit here, it's a really interesting thought.... but when you talk about a low point of a river or lake or something, you're talking about an area that's physically lower than another point, right?....So you're saying that those water molecules are going to find a way down to the lowest point of the cloud?
4. Engaging student ideas by considering their plausibility and coherence within the student's own line of reasoning (and not necessarily for the purpose of correcting or leading to the cannon).	Global warming. I'm still wondering about- Is it, did you say that Jared? If the heat gets stuck going out, why doesn't it get stuck coming in? What stops that from happening?... So if the carbon blocks it to go out, how come it doesn't block it to come in?
5. Making connections among student ideas, such as juxtaposing, comparing, and noticing inconsistencies among ideas.	So you have two lines of thinking, one it will end at the end of the atmosphere, the other is it would just keep going out into space.
6. Making specific requests for meaning at a meta level, such as inviting students to defend positions about specific ideas or explicitly inviting students to assess claims for coherence and plausibility.	What do you think, and I'm going to open this up to everybody, I don't want you to think I'm sitting here grilling you. But I'm really intrigued by it though. So what umm what would cause those water molecules that are in a gas state, once they're up in the cloud, what's actually going to cause them to move from just every other part of the cloud down to that low point, if that's the case, what do you think?

Table 2.
Examples of teachers' reflections on shifts in their teaching.

Shift in Teaching	Evidence from teachers' interviews and reflection papers
Shifting away from teaching centered on delivering lesson plans and conveying facts to teaching that privileges student thinking and their engagement in inquiry	"I started the beginning of the year the same way I always had, teach the curriculum using the materials provided by the district and don't stray away from that. As I continued throughout this course I inched my way towards a different approach..[...] I now create questions that evoke thinking and problem solving that ultimately allows my students thinking to take the forefront, not my well-constructed lesson plans. The students' thinking is now in the driver's seat." (Kim) "Prior to these classes, I taught Science in a very traditional way: Here's the topic, new vocabulary to use, practice with new concepts, apply new concepts, test and move on. [...] I don't think that my job as a Science teacher is to teach facts about Science anymore. I now think that my job as a Science teacher is to teach students how to: observe the world around them; question it and how or why it works; hypothesize and then test ideas; problem solve and analyze when things don't go as expected; share and listen to findings with others; be reflective; and have stamina to focus on a topic until you have a deep understanding." (Jessica) "After taking these classes, I feel a renewed sense of responsibility to incorporate that basic idea of teaching into listening to my students as they think about concepts [...] To look back at where I was in September compared to now, I can see a change - I am no longer the "old-school"-veteran teacher who will open yet another school year the same way I have for the last 25 years. I feel like I have a bigger job to do. Not only do I owe it to my students to create life-long thinkers, but I owe it to myself to make sure I am giving the students a strategy to take life by the horns and think!" (Dione)
Developing facility with attending to student thinking and orchestrating discussions that build on student ideas	"I feel *far* more comfortable listening to student ideas, seeking clarification, and analyzing them for meaning than I did even several short weeks ago. I also feel far more comfortable with my classes all being at different points in their discussions/investigations than I previously was." (Carlos) "I feel that one of the biggest areas that I have seen progress in is my ability to listen, and try to understand what students are saying. I feel that this alone has led to much better discussion in my classroom. I have been working on carefully listening to what the students are saying and asking questions of them to further their thinking and explaining. (Kayla) "My thoughts and approaches to how I conduct conversations in my classroom have progressed a great deal. [...] Even as I first tried to let them guide the conversation a few videos into the courses, the students could still tell by my tone that I was driving at something and too many students read this correctly and stopped taking chances with what they thought and waited for someone with the "right answer" to speak up. It was not until almost the very end that I "pulled it much more together"." (Gabriel)
Noticing a shift in classroom dynamics towards deeper student intellectual engagement and agency	My modeling of this behavior, and showing an actual interest in what the students are saying has rubbed off and I now see students doing the same thing. They are asking their peers to further explain their ideas when they do not understand something and questioning their peers when there are inconsistencies in what they are saying. I have found that when students are asked to further explain their thinking, or explain an inconsistency they gain a better understanding and are learning to problem solve and reason with their ideas. In addition, students have learned to listen to each other and are truly trying to understand what the other students are saying. Furthermore, having this open dialogue in my classroom has facilitated an environment where the students

are eager to engage in deep thoughtful conversations and genuinely interested in what their peers are saying." (Kayla)

"I have learned what is really important for my students and that it is not just 'canon' but the reasoning, evidence gathering, and collaborating that occurs around it"." (Peter)

"When our students can do these things, they will have access to any and all science facts when they want them. Without these skills, our students will continue to try to memorize facts that don't have meaning or value for them. Which means, it won't last in memory." (Jessica)

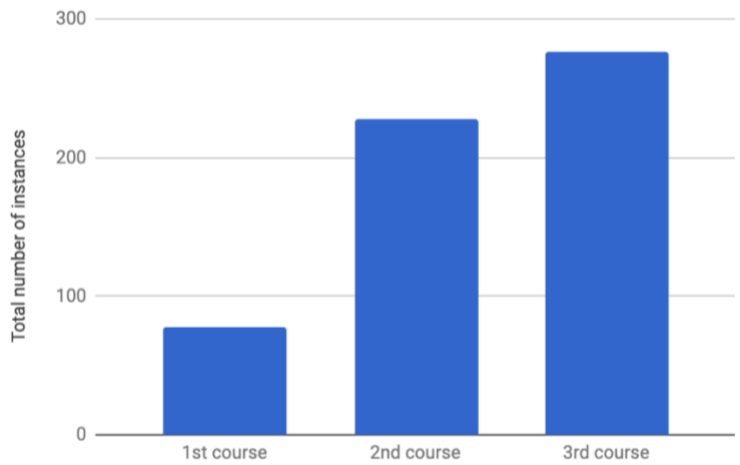

Figure 1. Total instances of teachers' taking up students' contributions as scientific over the three-course PD.

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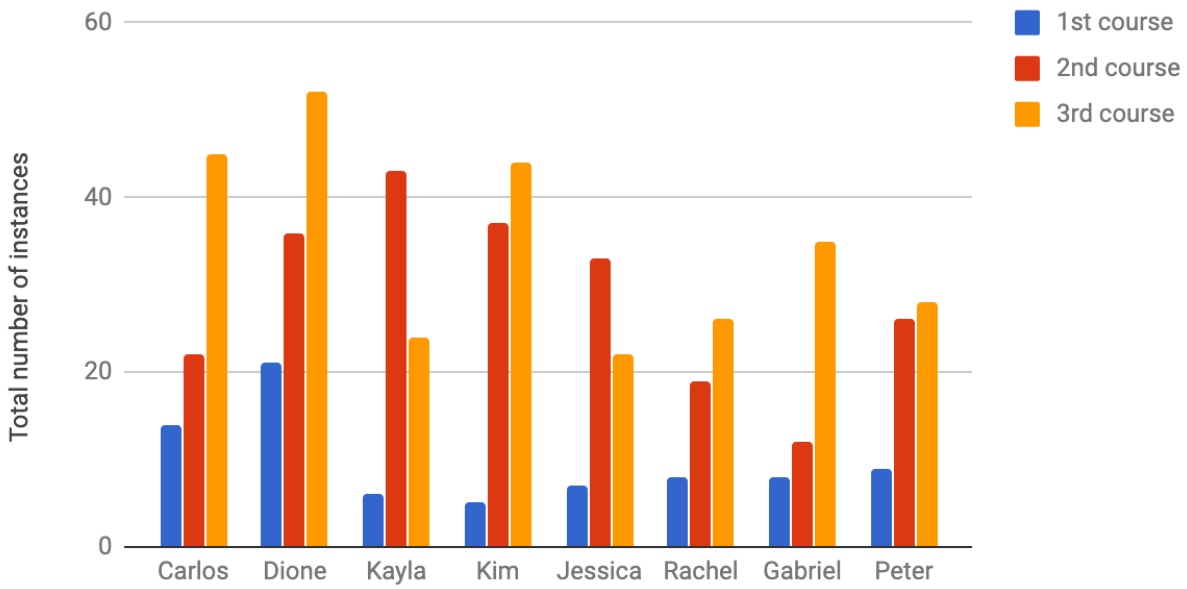

Figure 2. Instances of each teacher taking up students' contributions as scientific over the three-course PD.