Coloring the Relationship of Frames and Responses in Teacher Noticing

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This study builds on Louie, Adiredja, and Jessup's (2021) sociopolitical turn on teacher noticing. In this study, I use graduate student instructors' experiences as students and perceptions of their desirable actions to add nuance to the way Louie and colleagues discuss (anti-)deficit frames and noticing. The study uses a novel analytic framework to organize aspects of frames that begin to hint at a complex relationship between deficit and anti-deficit framing and responding.

Keywords: frames, teacher noticing, responding, graduate student instructors

There have been strides in our understanding of how graduate students develop as instructors (Beisiegel et al., 2019; Miller et al., 2018). However, we still require more nuance in the discussions of the development of teaching skills for graduate student instructors (GSIs), including in instructors' noticing within teaching. Typical descriptions of noticing tend to model instructors who respond to students in deficit-based ways as those who frame mathematics and learning in deficit-based ways; and instructors who respond to students in asset-based ways likewise are those who frame mathematics and learning in asset-based ways (e.g., Louie et al., 2021). Although scholars recognize this conception is idealized, there are few examples in the empirical literature of a more complicated relationship between framing and responding. In this proposal, I share results from an interview-based study of GSIs that provide such examples.

In this study, mathematics GSIs were interviewed before their instructor orientation to recount their experiences as students that I will argue inform the GSIs' noticing. This contributed report stems from a larger study of how GSIs develop their frames of teaching and learning within their first semester of teaching as the instructor of record. With the exploration of graduate students, the conceptual contribution of this study is to build on Louie, Adiredja, & Jessup's (2021) teacher noticing framework by coloring the gray relationship between deficit and anti-deficit phases of noticing and articulate a possible spectrum between deficit and anti-deficit frames and teaching responses. The professional contribution of this study is to clarify the professional development (PD) of GSIs by expanding the PD organizers' training for noticing skills.

These research questions guide the study: (1) *How do pre-PD first-time GSIs discuss student learning and their desired teaching practices?* and (2) *How do these discussions clarify our understanding of frames and noticing?*

Motivation from the Literature

Within the circles of research in undergraduate mathematics education, the development of graduate students as instructors is a shared curiosity. Miller et al. (2018) provided a literature review on the growing literature of GSI development which echoed the need for more understanding of how graduate students develop. In the following years, there have been studies that encompass various avenues of GSI development such as the obstacles of mathematics GSIs face in this development (Beisiegel et al., 2019), factors that influence GSI pedagogical empathy (Uhing, 2020), or the different types of programs that prepare GSIs to be instructors of undergraduate mathematics (Bookman & Braley, 2022; Ellis, 2014).

In a different focus, König and colleagues (2022) conducted a systematic literature review of 182 articles focused on teacher noticing conceptualization, study design, and findings. Within these, they found discussions of comparisons between novice and expert teachers (König et al., 2022, p. 13). However, there was no highlighted discussion of how an instructor develops their noticing skills. In particular, GSI and novice instructors' transition from student to instructor has yet to be explored in research of teacher noticing. Following the call for research of mathematics GSI development and this gap within the literature of noticing, this study continues exploration of the specific skill of noticing within the population of first-time teaching GSIs.

Theoretical Perspective

As discussed in König et al. (2022), teacher noticing has different conceptualizations (p. 8). This study follows from Jacobs et al. (2010) in which they deconstructed and extended the facets of noticing into three interrelated skills: attending, interpreting, and responding (AIR). *Attending* means to identify what is most important in the classroom (van Es & Sherin, 2008). *Interpreting* means to assign meaning to objects, such as students' questions, spoken or written solutions (van Es & Sherin, 2008). Lastly, *responding* alludes to the plan or action of answering the interpreted or attended student contribution in the classroom (Jacobs et al., 2010).

Hill and Chin (2018) provide a recounting of the role AIR has had in instruction. For example in classroom management (Star & Strickland, 2008) and responding to meet students' needs (Barnhard & van Es, 2015; Jacobs et al., 2011). They then investigate the interplay between teacher knowledge, instructional practice, and noticing; namely in the realm of "teacher knowledge of students" (Hill & Chin, 2018, p. 1105).

Relatedly, Louie (2018) continued the conversation of *equitable* noticing (Wager, 2014) in which her participant, Amanda Pepper, illustrates the barriers that caused her to still see students' deficits in spite of her substantial skills in noticing that focused on seeing students' mathematical strengths (p. 67). Years later, Louie and colleagues (2021) took a sociopolitical turn in discussing teacher noticing. They build on previous works, especially of Jacobs et al. (2010), to introduce the presence and influence of frames on the AIR teacher noticing framework, dubbing their proposed framework of teacher noticing FAIR. In short, frames (Goffman, 1986) are the interpretive contexts that participants of a given situation use in order to quickly interpret information, filter the details, and decide how to appropriately proceed. It is the vehicle that allows a person to be able to answer the question "What is it that's going on here?" (Goffman, 1986, p. 8) after attending any current situation.

In Goffman's discussion of frames, there is a strong suggestion that the frames one uses strongly dictate their actions. Louie and colleagues take from Greeno (2009) to understand that "frames provide interpretive contexts that support participants in a given situation to understand what kind of task they are engaged in, what kinds of knowledge are relevant or valuable, and what sort of behavior they and others are expected or entitled to engage in" (Louie et al., 2021, p. 3). In illustrating the utility of the FAIR framework, they acknowledge the gray area between deficit and anti-deficit noticing but chose to use two examples with "sharp contrast" to illustrate how consequential framing can be for noticing (Louie et al., 2021, p. 4).

To build their illustration of deficit framing and noticing, Louie and colleagues discuss how "it makes a great deal of sense" for teachers to attend, interpret, and respond in a deficit manner when teachers frame mathematics learning as "absorption of a universal, objective, and fixed body of knowledge" (Louie et al., 2021, p. 5). Here, deficit noticing involves "attending to accuracy and correctness", "interpreting mathematical work [as only] correct or incorrect", and "responding by affirming correct answers and remediating errors (Louie et al., 2021, p. 5).

In building a parallel illustration of the FAIR framework for anti-deficit contexts, Louie and colleagues began with the "AIR" component and ascertained the "F" that shaped the particular noticing. For example, using Oscar's case, they categorized instances of attending into thematic codes first (students, mathematics, and interactions), and then used literature on deficit or equitable frames to theorize the interrelation between framing and these themes. These two illustrations may suggest the same influence that Goffman had, in that deficit framing leads to deficit noticing or anti-deficit framing leads to anti-deficit noticing.

I understand that the FAIR framework is a model of the relationship between frames and noticing, and their discussion focused on the utility of frames in discussing noticing. This discussion does not do their work justice, as Louie and colleagues discuss more than just these illustrations. The best (or worst) case-scenario illustrations of anti-deficit (or deficit) contexts is a helpful model in accounting for frames in noticing, but frames likely cannot dictate all actions and responses. They have done extensive work in illustrating the complex web between the parts of FAIR as well as how the contexts outside of a classroom has a strong influence on the frames of teachers (Louie et al., 2021, p. 11). For now, this report aims to complicate this FAIR framework by focusing on analytically unpacking frames, which colors the gray area that Louie and colleagues mentioned briefly. This is focused on the framing and the responding parts of the FAIR framework and discuss the research implication for the other parts in the conclusion.

Data and Method

The data used in this report comes from a larger study of mathematics GSIs teaching for the first time as instructors of record. Instructors of record are responsible for the content-delivery and assessments of these undergraduate mathematics courses (Rogers & Yee, 2018). This study took place in a large, public, R1 university. More specifically, the interview data used in this report was collected weeks prior to their first PD and official preparation to teach as instructors of record. These four GSIs will be teaching either an "intermediate algebra" course which cover ideas that "are prerequisites for tackling college-level mathematics" or a "college algebra" course which is not commonly deemed as college-level mathematics, like calculus, differential equations, or linear algebra (Burrill et al., 2023, p. 799). Each GSI chose their own pseudonym.

I am a mathematics GSI myself. While the benefits of rapport and confidence helped in acquiring participants, the relatable experience of being nervous about teaching for the first time has an unavoidable influence on the data collection and analysis. For example, the guiding principle that one's past experience of being lost in a college course influences their future desired actions and expectations as instructors of record is a direct result of the author's experiences as a GSI.

The structure of interviews supports analysis of GSIs' preliminary frames, with the caveat that I am limited to only their perceptions of responses as they have yet to teach. The guiding philosophy of the interview was to orient GSIs into their past experiences. By first asking about a college course that they felt "really lost" in, this reveals their desired expectations and actions better than recounting a time where mastery came naturally. This philosophy stems from the author's experience of better articulating what he wants to do as an instructor when the context is bettering a challenging experience. For example, the question "What expectations should the instructor [of the "really lost" class] have had…?" revealed desires of wanting to break the monotony of lectures to implement student-to-student discussions when confusion arises. This can gather information about how they frame learning as collaborative or how instructors should respond to perceived confusion. Additional questions were asked that allows investigation of

frames and responding such as “In your view, how do students learn math?” or “when you think of a skillful teacher, what is that person doing?”.

Analysis proceeded by first giving a descriptive summary for each question immediately after each interview. Then, focusing on individual interviews, each response was analyzed closely to highlight ideas about teaching and student learning. Thus, for each interview, a profile of the GSI was built using the guiding questions: “what attitudes does this person have towards student learning?” and “how does this person’s attitudes compare to the (anti-)deficit frame models from Louie et al. (2021)?” In particular to organize data for the latter, a novel researcher analytic framework organized into a table (Table 1) was used, which the larger study this report stems from is trying to elucidate its viability as a researcher tool for frame analysis.

Table 1. Researcher framework for examining instructional frames

Frames provide interpretive contexts that support participants’ **understanding of**…	Frames of teaching provide interpretive contexts that support GSIs perceptions and enactment of…	Frames of learning provide interpretive contexts that support GSIs perceptions and enactment of…
(1) What role(s) they take up	What their role is in the classroom as novice instructors	What do GSIs have to do for students to learn the intended content, practices, and orientations
(2) What knowledge is relevant or valuable	What professional knowledge is relevant in the act of teaching	What content, practices, and orientations should GSIs attend to in the classroom
(3) What sort of interactions they and others are expected or have the right to engage in	What type of interactions (instructor-student, instructor-group, student-student) are favored or useful in fulfilling their role and achieving the intended learning goals	

Here I discuss the formulation of Table 1. The compartmentalization of frames is motivated by Greeno’s (2009) work, which Louie et al. (2021) also use to discuss frames. Its construction was motivated by asking “how can a researcher establish that one instructor’s frame is different from another?” The change of wording from participants’ “understanding of…” to “perceptions and enactment of…” is key, because this framework addresses the participants’ point of view on the three subdivisions as well as the actions that follow. Professional knowledge (Kunter et al., 2013) refers to the many different facets of knowledge an instructor could have such as content, pedagogical content, organizational, pedagogical/psychological, and counseling knowledge. This functions to clarify what Greeno meant by knowledge in a way that still broadly covers the types of knowledge that instructors draw upon for teaching. Content refers to the curriculum of the course, these are what the instructor must cover according to the department. Practices is a general term to refer to the behaviors one can learn as a mathematician like collaboration or justification. Lastly, orientations cover the abstract such as the attitudes towards the subject like confidence and self-efficacy.

I also want to highlight the combined section row for teaching and learning. While the middle column of Table 1 reads as the instructor’s interactions with the broader profession of teaching and pedagogy, the right column serves as the instructor’s intrapersonal connections to

the act of teaching. As such, it felt natural to combine the final row as a sort of bridge between the two sub-definitions of frames. Using the guiding questions, the preliminary frames and perceived ways of responding are organized for each GSI.

Results

In organizing these results, Table 1 was used as a way to organize connections, such as "how have these three framed what it means to learn mathematics?" In the responses to "how do students learn math?", there is a common thread among all four GSIs in framing student learning as learning by doing and highlighting the importance of student-student interactions.

Interviewer: In your view, how do students learn math?

Andy: So like the first part of math, like high school math. You can kind of do, so to speak, on your own in the sense that you can repeat it and see the patterns between examples, and from their branch out into other examples, because you can see the structure better. and knowing that structure, and being able to extrapolate on that structure, is still useful to you, an integral in later parts of math. But I think that in proof math it starts to become more social, because you remember certain things from like true, that stood out to you as elegant and useful, and other people remember different things from the lecture that's been as elegant and useful, and you all have your different preferences on what proofs you like to use.

Paul: The biggest component is doing it yourself, as in like doing problems.

Longboat: They learn by exploring it, trying things out, and more importantly, discussing with people [sitting] behind them, the peers, the other students. That's important.

Past this point, differences start to arise. These three GSIs also discussed how learning starts with an introduction that covers the "big picture" concept which then develops into more intuition and understanding by doing more and more examples. For these three GSIs, the instructor's role is explicitly noted as the person who introduces the concepts and chooses the "right" examples. The fourth GSI, Carlos, discussed learning through the lens of how they learn mathematics which differs from the other GSIs since they take it upon themselves to find more challenging problems to work on.

Carlos: I'll talk like from my point of view, like how I like to learn math… I like to go to lecture, ask as many questions as I can during the lecture, … take notes, go home, read the notes, [and] understand what is going on in the notes. And if I don't understand something, I go to office hours, ask questions there that are like more in depth. And then but oh, before that I try to read the book… It's like very good at supplementing the course. Then, also a lot of problems, or like challenging homework problems that are like more challenging than the stuff that I would see inside the classroom. And so I like to work on the homework like if I have a problem to work on, I work on it for like 30 min to an hour. and then if I don't get anywhere. I stop after an hour like after 30 min to an hour. and then ask classmates. and if we don't figure it out, I ask After 30 min to an hour with a classmate, I ask the instructor. during off hours. And that's in my view how this student [points to themselves] learns math.

Now, compiling the responses to questions that center teaching practices, three common teaching practices arose: (a) having awareness of the climate of the classroom, (b) being well-prepared in content knowledge, and (c) creating a collaborative, supportive environment. These

practices are then translated into descriptive codes (Miles, Huberman, & Saldana, 2019): climate, content, and collaboration. Below are representative quotes for each of these themes that demonstrate each theme the best but note that each participant spoke of each theme.

Paul: **(climate)** I noticed I liked a lot about [graduate course] and his instructor style. It felt like he was pretty good at noticing when the class was lost. and sort of pausing to take a break and be like, "Okay, check in with your neighbor, talk about what's going on, where or what's gone wrong." I think that's an important aspect.

Andy: (**content**) I think a skillful teacher is one who has an understanding of their knowledge base, and also the ways that people can misinterpret it when they first see it.

Carlos: (**collaboration**) One thing that I think any class should have, for example, is to make sure that, like you're a good classmate, not just like a good student. That definitely, I think, should be verbalized in any classes, especially in that one.

Through Table 1 and these themes, these four GSIs have framed teaching and learning as requiring content knowledge to attend to students doing problems, but also requiring sensitivity to the comfort of the students to create a space conducive to learning from each other.

Since these GSIs have yet to enter the classroom as instructors, the study takes the three themes above to allude to their perception of responding in noticing. For an explicit exploration, Longboat has framed the act of learning as an exploration filled with students asking questions and making conjectures and their responding maneuver during this exploration is to be hands off:

"I explained a bit of a concept, say the derivative. Maybe I don't give the full story yet. I just give them some precursors to it… Then I say 'for the next 5 minutes, just to the person behind and next to you, ask what's this good for?' I think these vague, open questions are good because you've given them an idea the students know it has to do with something you've talked about, right? They don't know exactly where we're heading… You expect students to have this mini research mind, they should be in the head that you explore math. You don't just solve it. So trying things out… They shouldn't discuss it with me, because I know what the answer is… So, give them a safe haven with their peers, where they can say anything… and as always allow students to make mistakes."

Longboat's response above provides one of the motivating complications to the FAIR framework. In one interpretation of this response, this was seen as dismissive as it disallows students from seeking answers from their instructor. But, in further exploration, this stems from Longboat's insistence that learning does not happen by having answers "thrown" at students and their belief that mathematics (research) is not given, but is discovered through exploration.

Another example, Andy has framed the act of learning with a skeleton metaphor:

"You have to get some picture of what you're looking for, and then see it a lot of times to be able to really see the basic skeleton. And then you can try to fill out that skeleton depending on what problem you're working on."

For them, the instructor's role is to give an "introductory picture of what that skeleton might look like" and provide a range of examples (simple to difficult, unambiguous to ambiguous) that allow students to add to the skeleton in different ways during different problems. Longboat and

Andy both share the frame that learning occurs when there is student exploration, but they differ in their way of perception of responding to this frame. While Longboat has a hands-off approach, Andy explores a range of examples alongside their students.

Lastly, as another point of comparison, GSIs also learn through exploration of "more challenging" problems, which is expressed in Carlos' large quote above, however Carlos' perceived role as instructor is to be there for students to approach with questions. This parallels Longboat's students' exploration but contrasts Longboat's instructor role, as students are not disallowed from asking questions.

Discussion

This contributed report set out to build on the work of Louie et al. (2021) bringing frames into the AIR teacher noticing framework. The results of the reported study entangle the relationship between anti-deficit or deficit frames with anti-deficit or deficit responding. With Longboat, Andy, and Carlos, a suggestion of a spectrum rises in the gray area between anti-deficit and deficit ways of responding. Even though these GSIs agreed in framing student learning as including exploration of various problems, their ways of responding branched out in different ways. Similar to Louie et al. (2021), it is reductive to label instructors' noticing as purely anti-deficit or purely deficit as it is rarely the case that noticing is (anti-)deficit in every situation. As in Longboat's situation, their way of responding (not discussing with students during their exploration) could be seen as deficit (when viewed as dismissive) or as anti-deficit (when viewed as a total belief that students are capable of exploring on their own).

Implications and Future Direction

This study was only able to focus on their frames and their perceptions of responding. With that, future research should explore where "switching" happens. Since there is a perceived flow from attending to interpreting to responding, future work can explore where the switch from deficit to anti-deficit happens along this chain.

An implication of this study for professional development organizers is to understand the complicated nature of anti-deficit framing and anti-deficit teacher noticing. On one hand, the author now understands that even if novice instructors are taught the same anti-deficit frame to approach teaching and learning, these can morph into different expressions that could be taken as deficit by their students. On the other hand, this complication of the FAIR framework alludes to a spectrum that can form a pathway from deficit responding to anti-deficit responding that PD leaders can utilize to train instructors to provide more equitable experiences for students.

A consequence of this study is that, even before formal professional development or experience as instructors of record, mathematics graduate students have nuanced perceptions and thoughts about their future teaching and what it means to be a skillful teacher. The larger on-going study this report stems from assumes that these perceptions are continuously shaped during their experiences as students in their mathematics courses. As such, more studies in leveraging graduate students' experiences as students to improve, augment, or re-design aspects of the graduate student professional development and preparation to teach undergraduate mathematics.

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