

Responsiveness as a Disposition and Its Impact on Instruction

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There is evidence that instructors who are responsive to students' thinking tend to provide more positive learning experience for students. Additionally, effective instruction relies on an instructor's ability to respond to student thinking, which is especially relevant due to the increased attention on improving college mathematics instruction. In order to investigate instructor responsiveness to student thinking as a disposition (that guides action) and responsiveness to student thinking as an action (the enacted evidence of the underlying disposition), eight college Calculus instructors were interviewed three times over the course of one academic year. A thematic analysis of the task-based interviews indicated that instructors who exhibited a responsive disposition to their students' thinking enact this through eliciting student thinking, reflecting on student thinking, and responding to student thinking. Further, these instructors view themselves as decision-makers, and thus feel empowered to act on their responsive disposition.

Keywords: Instructor dispositions, decision-making, noticing

Effective instruction relies on an instructor's ability to attend and respond to students' mathematical understandings and strategies (Jacobs, Lamb, & Philipp, 2010). Additionally, there is evidence from the K-12 literature that an instructor's disposition towards student thinking also influences instructional decisions, including how they interact and respond to students (Sherin & Russ, 2014; Thornton, 2006; Schoenfeld, 2008). Specifically, it has been shown that teachers who are more responsive to their students' thinking are generally recognized as more effective teachers who provide more positive learning experiences (Thornton, 2006). This is especially relevant due to the increased attention on improving college mathematics instruction, and in particular, the focus on student-centered instruction. In order to further our understanding on how to most effectively implement such instruction, it is important for us to consider everything that contributes to college mathematics instructors' teaching practice. In this talk, we focus generally on responsiveness as a disposition, identify components of responsive instruction (enacting a responsive disposition), and compare this work to other existing frameworks examining similar qualities in teachers.

Research Related to Responding to Student Thinking

Although instructor dispositions towards teaching and students play an integral role in how instructional activities are chosen and enacted, it is not always clearly articulated what is encompassed by one's "disposition." Dispositions can refer to an instructor's beliefs, inclinations, values, attitudes, and ability, among other things (Splitter, 2010). For this talk, we draw upon Thornton's (2006) definition of "dispositions in action" that arose as a result of her work studying middle school teachers' dispositions:

Dispositions are habits of mind including both cognitive and affective attributes that filter one's knowledge, skills, and beliefs and impact the action one takes in classroom or professional setting. They are manifested within relationships as meaning-making occurs with others and they are evidenced through interactions in the form of discourse (p. 62).

This definition highlights that dispositions are more than simply latent values or beliefs, and that these interact with knowledge and influence instructional practices. Based on other's previous work and our own experiences, we hypothesize that an instructor's disposition towards student thinking influences how they interact with students during class or office hours, how they elicit and respond to student thinking, how they prepare for a lesson, and how they approach grading and thinking about student work.

In her work on dispositions, Thornton (2006) developed a continuum of examples using classroom discourse analysis that describes teachers' orientations to student interactions ranging from a *responsive disposition* to a *technical disposition*. *Responsive dispositions* are those that are responsive to the needs and learning of students, including emotional, cultural, and development needs, and *technical dispositions* are those that involve going through the motions of teaching, but not engaging on a deeper level to probe, understand, or facilitate student learning. Thornton (2006) notes that with technical dispositions, instruction varies little from student to student and from situation to situation. This framing of teacher dispositions on a continuum lends itself to distinguishing between teachers who view themselves as in-the-moment decision-makers and those who do not. More specifically, one would expect teachers who view themselves as decision-makers to continually direct classroom interactions in order to align them with their goals for student learning as well as with their students' current thinking (exhibiting responsive dispositions). Conversely, teachers who carry out their role technically are expected to follow their prescribed lesson plans or pedagogical goals without deciding to adapt to the needs of the class or students (exhibiting technical dispositions).

One of the most developed models for considering teachers as decision-makers comes from Alan Schoenfeld who has worked to describe how knowledge, goals, and beliefs interact to shape instructional practices and decisions (Schoenfeld, 1998). His work provides evidence that an instructor's knowledge about the content, context, and pedagogy influences the types of things that they attend to during instruction and why they make certain decisions. Additionally, an instructor's goals (short or long term) influence how they decide to respond in the moment. For example, if a student asks a question in class, the instructor has to decide how they want to answer (with a mini-lecture, class discussion, etc.) and how long they want to spend answering the question and when (either now or later); these will vary depending on the instructor's immediate and long-term goals for student learning. Further, an instructor's beliefs and dispositions influence which goals they prioritize. Schoenfeld (1998) notes that certain beliefs, knowledge, or goals can be strongly activated at a particular moment during instruction (either because of planning or an interaction) and that this can influence how the instructor decides to respond.

Schoenfeld (2008) has also noted that teaching is a system that involves coherence between teacher commitments and values. He highlights that even when teachers are flexible and responsive to student thinking in their classroom, attending to multiple or conflicting goals, it is possible to model their decisions with consistency. This illuminates the connection between an instructor's underlying beliefs and the instructional decisions they are making, further highlighting that responsive dispositions can be enacted through decision-making.

Another framework that unpacks how teachers act as decision-makers is that of professional noticing (Mason, 2002; Sherin, Jacobs, Philipp, 2011), which has been used as a way to connect an instructor's knowledge and practice with their disposition towards student thinking (Hand, 2012). This framework focuses specifically on how a teacher decides to respond to students' mathematical understandings, complementing Schoenfeld's framework that models all the

decisions an instructor makes while teaching. Jacobs, Lamb, and Philipp (2010) describe noticing as: attending to, interpreting, and deciding how to respond to student strategies and understandings. An instructor's disposition to student thinking has been shown to impact the types of things that they attend to during instruction, impacting how and what they respond to (Sherin & Russ, 2014). We conjecture that in order for teachers to effectively attend, interpret, and respond to their students' understandings, they must have a responsive disposition that values student contributions and allows them to capitalize on their role as decision-maker.

The frameworks discussed above focus on in-the-moment decision-making, highlighting different processes and aspects that impact instructional decisions. Schoenfeld links knowledge, goals, and beliefs with decision-making, and Jacobs, Lamb, & Philipp link attending and interpreting with how an instructor interacts with specific students' understandings. However, neither framework attends explicitly to the underlying disposition that guides instructors' behavior - their responsiveness to student thinking - and how instructional decisions shed light on this underlying disposition. This study is guided by the following research question: How do college calculus instructors exhibit responsiveness to student thinking? In particular this work investigates instructor responsiveness by focusing on both responsiveness as a disposition (that guides action) and responsiveness as an action (the enacted evidence of the underlying disposition). This distinction will be discussed more thoroughly throughout the paper.

Research Design and Methodology

This study is part of a larger mixed-methods study investigating the influences of college calculus instructors' dispositions towards student thinking. For this talk, we focus on the qualitative data collection and analysis component of this study.

To understand responsiveness as a disposition and how it impacts college mathematics instruction, we focus our study at one university and in one content area - calculus. We chose calculus because this is a course that impacts a vast array of students, with varying interests and educational goals, and is taught by a vast array of instructors with their own varying experience, interests, and educational goals (Bressoud, Mesa, & Rasmussen, 2015). For this study, eight Calculus 1 instructors from one highly selective institution were interviewed. Four participants were new graduate teaching assistants (GTAs) who were leading recitation sections, two were experienced GTAs who were instructors of record (with multiple semesters experience teaching Calculus 1), and two experienced teaching faculty. Of the teaching faculty, one was in her first year at this institution, but had several years of experience teaching as a graduate student at another highly selective institution. The other teaching faculty had received her PhD at this institution and had ten years of experience teaching Calculus 1 (and other courses) at this institution. These participants were selected because of their varying levels of experience instructing and interacting with students. Additionally, this variation of roles and responsibilities related to the instruction of calculus is likely to influence their perception of their role as decision-maker, and consequently provides greater insight into responsiveness as a disposition and how this is enacted in instruction.

We conduct this work from a situated cognition learning perspective which emphasizes the importance of context in the development of understanding and knowledge. From this perspective, it is essential to consider the multiple facets (i.e. content, level of instruction, teacher knowledge, teacher beliefs) that are tied to and interact to give rise to various knowledge impacting teaching practice (Putnam & Borko, 2000). Specifically, in trying to research and improve teacher practice, we must attend to teachers' dispositions as a part of this surrounding

context. Although interviews were conducted outside of a teaching context, instructors were asked to consider their teaching practice in addition to examining student work, which is a common and authentic practice for most teachers.

A series of three interviews were conducted with each of the participants over the course of one academic year. The first interview was designed to learn about the participants' experiences teaching, career goals, and perspective on what it looks like to be a good instructor. The second interview was a task-based interview adapted from one used previously to exam college instructor mathematical knowledge for teaching where instructors were asked to work through calculus prompts, interpret student work to those prompts, and then discuss how they would respond to the students' thinking (Speer & Frank, 2013). The third interview was designed to facilitate a discussion revolving around various responsive instructional practices.

The interviews were audio-recorded and transcribed for analysis. The interview data were analyzed using thematic analysis (Braun & Clarke, 2006), by first highlighting all utterances related to a consideration of students or their thinking. These segments were then coded as either demonstrating *responsiveness in action* or *responsiveness as a disposition*. Segments coded as *responsiveness in action* included segments where instructors were responding specifically to students' work (e.g. "I would just go back over the definition with them"), and segments coded as *responsiveness as a disposition* were segments that demonstrated a general attending to students' needs, learning, and understanding (e.g. "I [try to] put myself into [the students'] positions, thinking about if I am first learning this concept."). We then used open-coding to determine themes, paying specific attention to how responsiveness as a disposition influenced responsiveness in action. After arriving at three general categories that described how instructors' were enacting responsive dispositions (or not) in their practice, we coded the interviews using these categories, developing subcategories as necessary.

Findings: Towards Understanding Instructor Responsiveness

The thematic analysis shed light on how an instructor elicits, reflects, and responds to student thinking and mathematical understandings (demonstrating responsive instruction) serves as a proxy for understanding their underlying responsive disposition.

Eliciting Student Thinking

The thematic analysis of the interviews highlighted a few underlying reasons why instructors might elicit student thinking, shedding light on their underlying disposition of responsiveness. Instructors that elicited student thinking either sought to draw out understandings they anticipated students would have (either correct or incorrect), or sought to gain insight into student thinking in order to gauge understanding. There were also instances where instructors did not elicit student thinking explicitly; these tended to be situations where either the instructor was able to interpret student thinking from the student's work or they sought to interpret the work without prompting for student thinking (e.g. "Well, I'd first have to figure out what they were getting at in answering this question."). The following excerpts demonstrate possible motives for eliciting student thinking.

Eliciting to draw out common student errors: "I have been spending time every week coming up with five challenging problems, and I think, 'What's all the stuff they mess up on the test?' And I can put them all into [these] problems ... I said I'll work through all of these with you so they don't just blatantly do all the mistakes ... They'll kind of know that they are not sure what they're doing, ... and so I have noticed that by me kind of drawing these

to the forefront ... [they] seem pretty good when [there are] similar ... stumbling blocks on the later assessments.”

Eliciting to gain insight into student thinking: “The first thing I would ask them is for them, now that they have the opportunity to take as much time as they want, try to explain to me what they were thinking.”

Eliciting to guide a student through a problem: “I would probably just ask them like what’s going on throughout time - like which car is moving faster. And then based on that, which one went farther during this time.”

These excerpts shed light on instructors’ underlying disposition of responsiveness to student thinking. Instructors that exhibit a more responsive disposition tend to demonstrate a variety of motivations for eliciting student thinking, drawing out student thinking in a variety of situations. This ties back to their role as decision-makers who capitalizes on opportunities to incorporate and respond to student thinking. The most common of the subcodes listed above was that of *eliciting to gain insight into student thinking*. This is likely due to the fact instructors were asked to respond to students’ work several times throughout the interviews and they felt they needed more information about how the student was thinking in order to respond accordingly.

Reflecting on Student Thinking

Instructors who regularly reflected on their students and their students’ understandings demonstrated a responsive disposition towards student thinking. These instructors tended to reference students or their thinking when discussing the motivation behind various instructional practices and decisions. The following excerpts come from one instructor’s interview - note the variety of ways that this single instructor attends to students and reflects on student experiences and thinking. These excerpts together highlight a responsiveness (as a disposition) to student thinking, and provides insight into why they make certain instructional decisions enacting this disposition.

Reflecting on students’ affect: “I have felt that my students have a lot of anxiety just because they are trying to prepare for this test ... I am supposed to be very conscientious about how much information I share with my students, and I get that because we want the experience to be uniform. So if I am telling my students more than other instructors, then that is not fair ... I personally don’t care about fairness, but I understand that fairness is a consideration ... And it’s one way for me to alleviate my own anxiety, and my students’ anxiety was just to tell them what I wanted them to know ... I was still able to help them to focus on the things that I thought were important.”

Reflecting on student difficulties with content: “Right now my students across the board - so students who I know came in with strong backgrounds and students who came in with maybe weaker backgrounds - are all having trouble with sigma notation and writing down Riemann sums.”

Reflecting on student thinking when grading: “Definitely when I am grading I have more time and space to think, ‘Oh you’ve written down this thing in this weird way,’ let me try to figure out where it is coming from.”

Reflecting on student thinking when planning: “I mean ideally when I plan a lesson I think about what my students will struggle with and what they will feel very natural [with], but I don’t always do a good job of it. I don’t always have the time and space to really think about what exactly is going to be the challenging part, and I also don’t always do a good job of predicting what is going to be the challenging part.”

Reflecting on specific student thinking and understanding: “I would want for them to draw me a picture, ... because if they drew me just a single point, then I am worried that they are only thinking of this as single point instead of a single point in a continuous function. But if they are thinking of this as a single point in a continuous function, then I think that they have some understanding of what is going on with the limit.”

Other instructors demonstrated a responsiveness to student thinking by reflecting on common student errors, by trying to anticipate student thinking (e.g. “I just try to put myself inside their head as best as I can”), or by reflecting on their own experience as a student (e.g. “We try to think ... through the first time I learned this, what was tough for me. And we write that on the board and go over it. And I think a lot of the times we get it sort of correct, and some of the times we don’t.”). The most common theme among instructors was a reflection on common student difficulties or, in response to interpreting student work, reflecting on what the student might be thinking. Instructors who demonstrated a more responsive disposition towards student thinking reflected on students regularly throughout the interview regardless of specifically being asked to consider student thinking, which seems to impact how they enact this disposition in the types of decisions they are making.

Responding to Student Thinking

Instructors’ responses about how they would help students after interpreting their work in the interviews fell into a few categories that shed light on their underlying disposition of responsiveness towards student thinking. On one end of the spectrum, instructors responded to specific student work by selecting examples or explanations tailored to the student’s understanding, enacting a responsive disposition towards student thinking. Further, these instructors tended to discuss additional ways in which they responded to student thinking (during planning, grading, writing assessment, in-the-moment instruction, etc.), highlighting their role as a decision-maker enacting this responsive disposition. On the other end of the spectrum, there were instructors who demonstrated a lack of responsiveness to student thinking, or a technical disposition (to borrow Thornton’s (2006) term). These instructors typically responded directly to the mathematics prompt explaining how they would solve the problem instead of building off the student’s demonstration of understanding.

The following interview excerpts show the spectrum of ways instructors demonstrated responsive dispositions (or lack thereof) to students and their thinking.

Responsive to specific student’s thinking: “If [the student] drew another graph for me where it was decreasing and then increasing, then I would know they don’t really understand what the sign of the derivative means. Then I would have to go back into this idea. I could ... *<describes specifically what they would do>*... Whereas if they drew a correct graph, then I would know they were kind of grasping for where to go with this, and then we could talk specifically [about] if you realize that was a minimum, what should you have looked at next.”

Responsive to student thinking on homework/exam problems: “If I think [a problem is] going to send them down a completely wrong road, I either might change the problem a little bit or give them a hint, say, ‘Hey you notice this thing.’ But I think it’s important to at least be in the mindset when you’re writing down homework problems or exam questions or any of that, you have to be in the mindset of what somebody who doesn’t know the stuff very well would try.”

Not responsive to student thinking: “I would just abandon [the student’s] answer, and just start over with - I know this is the graph of f' , what does this tell me about the slope? Or what does f' tell you about the original function?”

Most of the segments coded as *responding to student thinking* were in the instructors’ responses to the prompt, “If this student were to come to your office hours, what sorts of things would you do to help them have a better understanding?” after examining the student’s work. It is important to note that individual instructors typically demonstrated various types of responses to student thinking throughout the interviews. Thus it is important to consider how an instructor responds to specific student thinking along with the other aspects of responsive instruction that shed light on their underlying disposition of responsiveness, namely how they elicit student thinking and reflect on student thinking.

Discussion and Implications

This analysis has illuminated the distinction between responsiveness as a disposition and responsive instruction. Instructors who exhibit a responsive disposition to their students’ thinking enact this through eliciting student thinking, reflecting on student thinking, and responding to student thinking. Responsive instruction is instruction that includes regular eliciting of, reflecting on, and responding to student thinking. We argue that instructors who exhibit responsive instruction have an underlying disposition of responsiveness. These instructors view themselves as decision-makers (Thornton, 2006), and feel empowered to act on their responsive disposition.

Instructors were even aware of this distinction between an underlying disposition of responsiveness and of what it looks like to be enacted through responsive instruction. This is demonstrated in the Findings section by the segment coded as *responsive to student thinking on homework/exam problems*. Here the instructor highlights the importance of being “in the mindset” of considering what students might do (demonstrating an underlying disposition of responsiveness) when he is writing exam or homework problems (enacting responsiveness through instructional decisions).

As mentioned in the review of the literature, previous work has focused on understanding instructors’ decision-making and noticing has highlighted the great variety in ways that instructor can be aware of and respond to their students’ needs (Jacob, Lamb, and Phillip, 2010; Schoenfeld, 2008). In this work, we have begun to unpack the underlying disposition of responsiveness that enables or constrains instructors’ actions as decision-makers responding to their students. By better understanding responsiveness, we can learn how it can be developed and utilize it to impact instructors’ practices as decision-makers.

Currently, much professional development surrounding student-centered instruction focuses on the teaching practices and the logistics of facilitating such learning. But since there is evidence that dispositions can be reshaped and developed (Hand, 2012), we should strive to not only improve instruction, but to foster responsive dispositions towards student thinking. As we gain a greater understanding of these underlying dispositions and how they impact responsive instruction (in how they elicit, reflect, and respond to student thinking), we can create professional development that more specifically targets this underlying factor that impacts instructor decisions and practice. Further, this area of research has the potential to drastically impact undergraduate instruction; since when we better understand how we can foster responsive dispositions and responsive instruction, we can better support students through student-thinking centered instruction.

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