Expanding Research on Responsive Teaching

Julia Gouvea[†*] and Lara Appleby[‡]
[†]Department of Education, Tufts University, Medford, MA 02155; [‡]Department of Physics & Astronomy, Tufts University, Medford, MA 02155

ABSTRACT
Over a decade of theoretical and empirical research, primarily in K–12 mathematics and science education, makes the case for the benefits of responsive teaching—an approach to instruction that centralizes student thinking. The new research described in this *Current Insights* provides quantitative support for the benefits of responsiveness, interrogates how responsive teaching is conceptualized and practiced to support equity, and invites the biology education research community to consider how to make responsive teaching more common at the undergraduate level.

INTRODUCTION
Responsive teaching describes an approach to science and mathematics instruction that foregrounds *students'* ideas (van Es and Sherin, 2008; Robertson *et al.*, 2016).[1] Foundationally, responsive teaching builds from the constructivist understanding that students bring "productive beginnings" of disciplinary ideas and practices to learning environments and that their learning is best supported when those ideas are made the focus of instruction. In practice, responsive teaching has been described as teachers' efforts to: elicit and notice students' thinking; listen and attempt to understand students' ideas; and use those ideas to inform adjustments to the trajectory of a discussion, lesson, or semester plan.

More than a decade of research in science and mathematics education has provided arguments and evidence in support of the benefits of responsive teaching for students, including gains in disciplinary learning and the potential to support equity. In this installment of *Current Insights*, we review recent advances and expansions in this area of scholarship. First, building on a foundation of research connecting responsive teaching to learning in STEM, Bishop reports on a quantitative link between responsive teaching moves and student achievement in mathematics. Second, Louie and colleagues argue that the potential for responsive teaching to support equity and justice has been undertheorized and understudied. These authors present a conceptual framework that can guide equity-oriented research and argue for the need for responsive teaching to be explicitly "anti-deficit." Third, most research and scholarship on responsive teaching has taken place at the K–12 level. Gehrtz and colleagues provide a descriptive study that illustrates the current state of responsiveness among undergraduate science, technology, engineering, and mathematics (STEM) instructors.

As a set, these papers motivate a need for additional research at the undergraduate level while also pointing to ways in which the concept and practice of responsive teaching will need to expand and evolve to fulfill its potential.

[1]The term "responsive teaching" has been more common in science education, while the term "teacher noticing" has been more common in mathematics education. We use "responsive teaching" in this article to refer to teaching that foregrounds students' thinking in STEM (see also Elby *et al.*, 2014).

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*Address correspondence to: Julia Gouvea (ulia.gouvea@tufts.edu).

HIGH TEACHER RESPONSIVENESS CORRELATES WITH ACHIEVEMENT TEST GAINS

Bishop, J. P. (2021). Responsiveness and intellectual work: Features of mathematics classroom discourse related to student achievement. *Journal of the Learning Sciences*, *30*(3), 466–508. https://doi.org/10.1080/10508406.2021.1922413

Bishop examined the relationship between teacher discourse and students' learning of mathematics by studying 13 middle school teachers who were implementing a reformed mathematics curriculum. She collected two forms of data: 1) transcripts of recordings of one class session for each teacher and 2) students' scores on a multiple-choice test administered before and after the 3-week curriculum unit.

Bishop's qualitative coding of classroom discourse captures the *degree of responsiveness* of teachers' moves. High-level responsive moves, such as asking probing questions, revoicing student thinking, or engaging students with a peer's idea, engaged with and explored student thinking. Lower-level moves centered the teacher's ideas or focused on correcting students. Bishop also characterized the *degree of intellectual work* represented in both teacher and student contributions. High-level intellectual work described the presence of mathematical reasoning and justifications, while the lowest-level work included simple requests for or presentations of information.

Across the 13 teachers, Bishop found relatively few turns of teacher talk that demonstrated high levels of responsiveness (13% on average), and examples of high-level intellectual work were infrequent for both teachers (14%) and students (22%). That is, despite the innovative curriculum, most class discussions featured teachers asking for and students providing mathematical facts or information.

Nevertheless, the variation in responsiveness and intellectual work did matter for students. At the classroom level, higher levels of responsiveness and intellectual work were positively and significantly correlated with gains on the multiple-choice assessment. At the discourse level, high levels of intellectual work in teacher questions led to more instances of students providing high-level responses. Further, Bishop's final multilevel model showed a strong, positive, and significant predictive effect of teacher responsiveness on student achievement (correcting for pretest scores at both the individual and class levels).

In addition to providing quantitative evidence in support of the benefits of responsive teaching, Bishop's study provides a simple analytic framework for describing the degree of responsiveness and intellectual work in classroom discourse. While created for a mathematics context, it could easily be adapted for use in science contexts.

Bishop acknowledges that, in line with much of the prior work on responsiveness, her study focuses exclusively on attention to students' intellectual contributions, ignoring, for example, how or whether teachers notice and respond to students' emotions. Bishop hints that attention to such information may be part of the mechanism that links responsive teaching to learning gains: students' feelings that their ideas and the ideas of their peers are valued may create positive conditions for learning. According to Bishop, such mechanisms may partly explain why responsive teaching approaches have been successful for many students from a variety of cultural backgrounds and in a variety of contexts. However, the next article argues that, in order for responsive teaching to realize its potential to support equity in STEM classrooms, there is a need to more explicitly respond to the sociopolitical discourses that influence teacher responsiveness and disproportionately affect students from historically marginalized groups.

THE NEED FOR "ANTI-DEFICIT" FRAMINGS IN RESPONSIVE TEACHING

Louie, N., Adiredja, A. P., & Jessup, N. (2021). Teacher noticing from a sociopolitical perspective: The FAIR framework for anti-deficit noticing. *ZDM—Mathematics Education*, *53*, 95–107. https://doi.org/10.1007/s11858-021-01229-2

Much of the literature on responsive teaching describes the practice as entailing three components: *attending* (paying attention to what students are thinking, saying, and doing), *interpreting* (making meaning of what students say and do), and *responding* (making instructional decisions and actions in response). Louie and coauthors argue that how instructors *frame* students, the discipline, and learning in the discipline can impact what they notice, the types of interpretations they make, and how they respond.

Crucially, Louie and colleagues illuminate how an individual teacher's framing can be, often unconsciously, influenced by dominant sociopolitical discourses. Mathematics education, like other STEM disciplines, is dominated by ideas about mathematics as objective and fixed and students as individual receivers of mathematical knowledge. These narratives can contribute to *deficit noticing*, wherein students' ideas are interpreted narrowly as correct or not and students themselves are labeled as either high or low achieving. Deficit noticing contributes to racialized harm by prioritizing the correctness of established (Western/white) approaches and devaluing student approaches that do not fit these fixed standards.

As an antidote, Louie and coauthors articulate the importance of *anti-deficit noticing*—"noticing that deliberately challenges deficit discourses, intentionally attending to and elevating the humanity, intelligence, and mathematical abilities of marginalized people, not in speeches or statements but in routine instructional interactions" (p. 100). Such noticing requires framings emphasizing: 1) that students bring many diverse resources to mathematical learning, 2) that these resources are useful for doing mathematics, 3) that mathematics is a discipline that involves the creative exploration of ideas and patterns, and 4) that relationships among students will facilitate their learning with and from one another.

Given the pervasiveness of deficit narratives, the authors suggest a need to actively work to "reframe" the work of noticing and responding to students. They illustrate this by describing the responsive teaching practices of Oscar, a Hispanic-identifying university mathematics instructor teaching in a summer bridge program for first-generation college students. The researchers interviewed Oscar about his noticing patterns and used examples from this interview to exemplify anti-deficit noticing. They describe how Oscar intentionally focused on identifying and celebrating the mathematical promise in his students. For example, Oscar interpreted one student's "willingness to just put things out there" as a strength that facilitated the process of exploring multiple mathematical ideas rather than as distracting or careless. In responding to students' work, Oscar focused on celebrating conceptual connections rather than pointing out mistakes. Further, Oscar was able to notice, value, and facilitate interactions among students.

In their work, Louie and coauthors expand the practice of responsive teaching beyond the skills of noticing, interpreting, and responding to include attention to the sociopolitical discourses that frame teacher responsiveness. They argue that noticing and responding to disciplinary ideas is necessary, but not sufficient to support learning for all students. Without explicit attention and effort to counter deficit narratives, instructors will not be able to respond constructively to students, especially those from historically marginalized groups.

THE BEGINNINGS OF RESPONSIVE TEACHING IN UNDERGRADUATE STEM

Gehrtz, J., Brantner, M., & Andrews, T. C. (2022). How are undergraduate STEM instructors leveraging student thinking? *International Journal of STEM Education*, *9*(1), ar18. https://doi.org/10.1186/s40594-022-00336-0

To address the gap in our knowledge of responsive teaching in undergraduate STEM contexts, Gehrtz and coauthors describe variation in responsiveness to students' ideas in relatively standard undergraduate STEM classrooms. They studied video of one class session from each of eight science and math instructors (with class sizes ranging from tens to a few hundred) at a single institution and interviewed each instructor before and after the class session.

Classroom video was used to estimate the proportion of class time during which instructors made space to observe or hear students' thinking in whole-class or small-group discussions. This measure can be understood to correspond to the amount of class time during which responsive teaching could possibly be employed. Interviews with instructors were used to examine pedagogical reasoning and behaviors associated with those opportunities to engage with students' thinking. In interviews, instructors reflected on video clips from their classrooms, articulated their relevant pedagogical knowledge (knowledge of students' thinking), and described and explained their pedagogical methods and decision making. Gehrtz and colleagues combined analyses of interviews and videos to define two coarse-grained categories of instructor behavior: *high leveraging* and *low leveraging* of student thinking.

Instructors whose classes included a higher proportion of opportunities to observe student thinking (37% of class time on average) and who described a broader range of strategies for accessing (e.g., posing questions), interpreting (e.g., listening for more than correctness), and responding to (e.g., adjusting the pace of instruction) student thinking were described as "high leveragers." Instructors whose classes had a smaller proportion of time devoted to student talk (14% of class time on average) and who described a narrower range of strategies, often focused primarily on correcting students or providing explanations "without using or building on student ideas" were described as low-leveragers. High-leveragers' additional access (in terms of percentage of class time) to information about students' thinking came mainly from their eavesdropping during small-group work.

Gehrtz and coauthors suggest that differences in instructors' beliefs and values may underlie different degrees of responsiveness. In interviews, high-leveragers expressed constructivist beliefs and exhibited more curiosity about student thinking, using evidence from students' talk to interpret what individual students may have been thinking. Low-leveragers did not seem to see value in collecting more information about their students and tended to rely on assumptions about students in planning and implementing instruction.

Like Bishop, Gehrtz and colleagues interpret their study as evidence that attending to and leveraging student thinking may be uncommon. Currently, responsive teaching is not the dominant mode of instruction at either the K–12 or undergraduate level. Nevertheless, these results are promising in that they illustrate that some STEM instructors may already be enacting the beginnings of responsive teaching by making time to access and consider students' ideas and by being flexible in allowing this information to inform their instruction, even in large introductory courses.

Even so, the examples of how even those instructors described as "high-leveragers" interpreted and responded to students suggest that their primary focus was students' *difficulties* and *confusions*. That is, while high leveragers are indeed trying to elicit and use information about their students to guide their instruction, they do not appear to be focusing on potentially productive aspects of students' thinking. The framework proposed by Louie and colleagues can help us understand this. Dominant discourses in STEM education and in STEM education research continue to frame the work of the instructor as anticipating and addressing students' difficulties. In line with this interpretation, Gehrtz and coauthors point to "contextual factors," such as large class sizes and pressure to cover content, as potentially undercutting efforts at responsiveness. In addition to overcoming these structural constraints, fully realizing the potential of responsive teaching may require broadening of what it means to access and leverage student thinking and active reframing of student thinking as creative, sensible, and complex.

Finally, Gehrtz and coauthors caution that a focus on students' *ideas* alone is likely to be insufficient for addressing issues of equity in STEM classrooms. The anti-deficit noticing described by Louie and coauthors and practiced by university teachers like Oscar involves attention to and engagement with all that students bring with them to learning environments—their many varied ideas, strategies, feelings, values, and modes of expression. These authors challenge responsive teachers to attend and respond to students in all of their humanity and challenge researchers to consider the broader sociopolitical narratives that influence teaching in real contexts.

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