Chapter 7

Emerging Perspectives on the Co-Construction of Power and Learning in the Learning Sciences, Mathematics Education, and Science Education

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In this chapter, we examine a significant shift in research in the learning sciences, mathematics education, and science education that increasingly attends to the co-construction of power and learning. We review articles in these fields that embody a new sense of theoretical and methodological possibilities and dilemmas, brewing at the intersections of critical social theory and the methodological approaches of interaction analysis and microgenetic analysis. We organize our review into three thematic categories: (1) the dynamic construction of identity and ideology, (2) attending to the organization of a learning environment, and (3) leveraging and repurposing tools. Reading across these thematic areas, we identify and outline a burgeoning subfield that we term critical interaction and microgenetic analysis. *By bringing this collection of articles together, this chapter provides collective epistemic and empirical weight to claims of power and learning as co-constituted and co-constructed through interactional, microgenetic, and structural dynamics. In our conclusions, we suggest six analytical commitments that are important to hold when engaging in critical interaction and microgenetic analysis.*

In *Identity and Agency in Cultural Worlds*, Dorothy Holland and her colleagues (2001) highlight the tensions in privileging an analysis of socially determining forces on one hand or individual human agency on the other. As they elucidate, an emphasis on societal structures tends to gloss over people's agency, creativity, and ingenuity, and a prioritization of individual agency often erases historical, social,

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political, economic, and cultural constraints. Along with Erickson (2004), Goodwin (1994, 2007), McDermott (1993), Wortham (2004), and others, they represent a swell of scholarship in anthropology that has emphasized the importance of simultaneously attending to the moment-to-moment improvisations as people interact with each other and their environment, and the ever present societal and local curtailments on human activity. The scholarship we reviewed in this chapter, as a collective, takes up and further extends this challenge with particular attention to learning: How does one theorize and study learning at a level of analysis where structure, context, and agency co-constitute each other?

Taken as a whole, the articles seek to move beyond assertions that historical, social, political, and economic processes shape and influence individuals in some underspecified or overly deterministic manner. Similarly, they are not content with post hoc narratives to substantiate claims that a certain dynamic of power was salient in a particular setting. They seek to empirically show how tools, representations, artifacts, resources, practices, bodies, and the design of learning environments are all imbued with histories of power and contestation *and* that people creatively employ and transform these elements to reify, nudge, perturb, alter, and/or transform existing relationships of power. The micro, meso, and macro, in this sense, cannot be fully disentangled. They are co-constituted, but forefront differences in scale, both temporal and spatial. This dynamic relationship stresses that analyses must not only attend to how macrolevel structures and ideologies afford and constrain microlevel interactions but should also attend to how the macrolevel outcomes, in part, arise from the accretion of microlevel interactions where people are always repurposing tools, reimagining themselves, renegotiating relationships, and improvising with practices and ideologies that may appear otherwise static and inevitable.

More specifically, we examine a significant shift in research in the learning sciences, mathematics education, and science education that embodies a new sense of theoretical and methodological possibilities and dilemmas, brewing at the intersections of critical social theory and the methodological approaches of interaction analysis and microgenetic analysis. Fine-grained analyses of learning have demonstrated rich and varied trajectories of sensemaking, participation, and becoming but have struggled to adequately capture historical, social, political, and economic processes of power. Similarly, research on power in educational settings often missed the mark on cojoining their links with learning into a "multidimensional, multilayered portrait of human activity" that shifted "away from models of reproduction and essentialism" (Nasir & Hand, 2006, pp. 468–469). The scholarship we reviewed has unequivocally taken up the charge to develop new theoretical and methodological tools to study the co-construction of power and learning. We address the following question:

How do emerging approaches to studying learning that integrate (1) microgenetic and/or interaction analysis approaches, and (2) theoretical frameworks from critical social theory, uniquely contribute to equity in education by conceptualizing and addressing power as simultaneously constructed in interaction and place and situated in history and society?

Reading across the literature we reviewed, we name what we see as the emerging subfield of *critical interaction and microgenetic analysis*. Before discussing our literature selection process and analytical strategy, we begin by defining key terms to help frame the analysis that follows.

ESSENTIAL TERMS

Power

Given that others have written tomes about the construct of power, we cannot fathom providing a conclusive definition of the term in a few lines. The dictionary definition is a helpful starting point: "the capacity or ability to direct or influence the behavior of others or the course of events" (New Oxford American Dictionary, n.d.). We also interpret power as the ability to alter or maintain the physical, social, structural, cultural, and political conditions, resources, and/or opportunities of individuals and collectives (Baldwin, 2013; Collins & Bilge, 2016; Davis, 1983; hooks, 2014). From our perspective, power is co-constructed at multiple scales—historically and structurally at the macrolevel, at the organizational and institutional levels, at the interactional level, and in and through the bodies of individuals themselves. At each of these levels, power is simultaneously coercive with the threat of force and violence and also ideological in that it exists as assumptions of "commonsense" and practices taken to be "normal" (Foucault, 1979; Gramsci, 1971; Hall, 1996). The operation and outcomes of power are sometimes aligned across these levels and contradictory at other times.

Interaction and Microgenetic Analyses

Researchers who employ interaction and microgenetic analyses are diverse in terms of their disciplines and the specific methods they employ. However, there are certain commitments that characterize these approaches. Researchers who employ interaction analysis share the premise that "knowledge and action are fundamentally social in origin, organization, and use, and are situated in particular social and material ecologies" (Jordan & Henderson, 1995, p. 41). As Jordan and Henderson (1995) further elaborate, "This view implies a commitment to grounding theories of knowledge and action in empirical evidence, that is, to building generalizations from records of particular, naturally occurring activities, and steadfastly holding . . . theories accountable to that evidence" (p. 41). The interdisciplinary methods that characterize interaction analysis empirically investigates "the interaction of human beings with each other and with objects in their environment" through close attention to "talk, nonverbal interaction, and the use of artifacts and technologies, identifying routine practices and problems and the resources for their solution" (p. 39).

While the roots of interaction analysis "lie in ethnography (especially participant observation), socio-linguistics, ethnomethodology, conversation analysis, kinesics, proxemics, and ethology" (Jordan & Henderson, 1995, p. 39), we see microgenetic

analysis as an important parallel set of methods that has its roots in psychology and cognitive science. Microgenetic approaches accentuate fine-grained processes of learning and change that occur "at the smallest observable time scales" (Parnafes & diSessa, 2013, p. 7). They seek a "moment-by-moment explanatory account of learning in particular contexts" and "conceptual resolution" that yields "very fine distinctions in meaning" that must be tracked (Parnafes & diSessa, 2013, p. 7). For Siegler (2006), microgenetic approaches are characterized by the following methodological commitments:

1. Observations span the period of rapidly changing competence.
2. Within this period, the density of observations is high, relative to the rate of change.
3. Observations are analyzed intensively, with the goal of inferring the representations and processes that gave rise to them.

Similar to the use of the term *critical* in fields such as critical discourse analysis (Fairclough, 1995), we seek to identify a body of work that has implicitly or explicitly linked interaction and microgenetic analyses with an examination of power. Critical interaction and microgenetic analysis forefronts that moment-by-moment processes of learning and change, and the interactions of human beings with each other and with objects in their environment, reflexively co-construct "wider social and cultural structures, relations, and processes" and "struggles over power" (Fairclough, 1995, p. 132).

LITERATURE SELECTION AND METHODS

We focus on the fields of the learning sciences, mathematics education, and science education given the overreliance in these fields on "static categories and group labels" that fail to account for the "socially and politically constructed nature of power" (Martin, 2009, p. 295). To bound this review, we examined articles published from January 2007 to March 2019 (the time of writing) from four leading journals in each of these fields. While some journals ultimately yielded few or no articles, we include them below to highlight the absences and silences across the field. The journals we reviewed are listed below and the final number of articles that met our inclusion criteria is indicated in parentheses:

- *Learning sciences: Cognition and Instruction* (5); *The Journal of Learning Sciences* (12); *Mind, Culture and Activity* (3); and *Human Development* (0)
- *Mathematics education: Educational Studies in Mathematics* (1); *Journal for Research in Mathematics Education* (3); *Mathematical Thinking and Learning* (2); and *ZDM: Mathematics Education* (0)
- *Science education: Cultural Studies of Science Education* (11); *Journal of Research in Science Teaching* (5); *International Journal of Science Education* (0); and *Science Education* (7).

To select relevant articles for review, we read through the titles and abstracts of each article that was published in these journals in the 12-year span we reviewed. In this phase, we included articles that used power as one dimension of analysis. We operationalized attention to power as analytically examining at least one system or structure of oppression, such as racism, sexism, heterosexism, patriarchy, ableism, classism, linguicism, and immigration status. In the second phase, we closely read each of the articles initially selected with a filter for whether or not they used microgenetic and/or interaction analysis. We included articles that were resonant with the methodological commitments of these approaches, even when they did not explicitly state the use of these approaches. The use of the second inclusion criteria severely narrowed the pool of articles that were finally included in this review. To elaborate, in the first phase, we identified numerous articles that centrally engaged power as a dimension of analysis. However, these articles relied largely on post hoc interview data or thick ethnographic descriptions but were not attuned toward interaction or microgenetic approaches. The inclusion of the second criterion yielded the set of articles that we finally included in this review.

We coded each of the articles (Jesson et al., 2011) for methodological approaches, significant methodological innovation, theoretical grounding, theoretical contribution, and study contexts. Given the diversity of theoretical and methodological approaches across the articles, we organized the articles into three thematic categories:

1. The dynamic construction of identity and ideology
2. Attending to the organization of a learning environment
3. Leveraging and repurposing tools

For each category, we characterized how the sets of articles contributed to the integration of interaction analysis and/or microgenetic analysis with critical social theory and highlighted and discussed exemplar illustrations of fusing interaction analysis and/or microgenetic analysis with critical social theory. Our categorization does not imply that articles included in one thematic area cannot or do not speak to the other thematic areas. Instead, our intention is to elevate themes that were prominent across different subsets of articles.

THEMES IN THE LITERATURE REVIEWED

Below, we elaborate on the three thematic categories that emerged in the literature we reviewed. In our representation of the themes, we provide a short overview of each article. We took this approach since the articles varied substantially in theoretical frameworks, methods, and disciplines and were only put in conversation by us given our focus on simultaneously attending to power and learning. Given the immense diversity within a relatively small body of literature, we felt it essential to represent the core findings of each article. As we elaborate in the discussion section below, this chapter provides collective epistemic and empirical weight to the understanding of power

and learning as co-constituted and co-constructed through interactional, microgenetic, and structural dynamics by putting these articles in dialogue with each other.

The Dynamic Construction of Identity and Ideology

A distinct and shared characteristic of the articles in this review is that they explicitly emphasized the moment-to-moment co-construction of power, identities, ideologies, and learning. This approach stands in contrast to perspectives that have assumed that learning takes place on the substrate of relatively stable and durable identities, ideologies, and forms of status and power. Critiquing these perspectives, Wood (2013) has argued that the most prevalent approaches "lack the sensitivity to account for variability" in who students are across time and place (Wood, 2013). As Wood (2013) argues, assumptions about stability often function to mask or render invisible variations in students' identities. She highlighted the need to attend to "micro-identities," or "identities enacted in a moment of time," in addition to the more common focus on "macro-identities," or "relatively stable, long-term constructions of who a person is" (p. 776).

By using positioning theory (Davies & Harré, 1999), Wood examined how dramatically students' identities could shift across a single classroom lesson. Her analysis identified the "offered position(s)" and "enacted position(s)" in each relevant turn of talk in one group of fourth-grade students interacting during a mathematics lesson. While most work on identity has ample caveats about multiplicity and variability, the typical reliance on interview data or summative narrations of participant observations often does not show the empirical basis or consequences of these theoretical conjectures. Wood demonstrated how close attention to micro-interactions among participants brings multiplicity and variability in identities to the fore, even across short timescales. Making a more explicit connection between possible micro-identities and macro-identities, Gamez and Parker (2017) used the construct of "micro-figured worlds" to study the subtle ethnic, racial, class, gender, and linguistic inequalities that emerged in two small groups. By focusing on two multilingual learners, they draw attention to the significance these subtle distinctions made in the groups and how they might differentially affect students from the "same" presumed identity category.

Through the lens of ideology, Philip (2011), Philip et al. (2016), and Philip et al. (2018) draw attention to the micro-interactions through which ideological stances are taken by participants, taken up by others, and contested and co-constructed in interaction. They demonstrate how participants' ideological stances construct oneself and others in the moment. Similar to Wood (2013), they show the large amount of variation that can be glossed over through accounts of ideology that emphasize stability and durability. In particular, Philip et al. (2018) studied an undergraduate engineering ethics course and showed how presumptions of relative ideological stability is better understood as an interactional achievement between participants that involve moments of ideological expansion and convergence. They define ideological convergence as "the narrowing of the field of ideological stances that are salient and seen as

useful as individuals participate in a joint activity" and ideological expansion as an "analogous broadening of the ideological field" (Philip et al., 2018, p. 185). They trace expansions and convergences using Du Bois's (2007) stance triangle, arguing that stances both evaluate an object and aligns or dis-aligns the stance taker to other participants. Their work troubles assumptions about the necessary salience of certain ideologies like American nationalism or the differential value attributed to civilians of different nationalities; they demonstrate how the participants had to co-construct relevant local ideological meanings, which drew on available macrolevel ideologies as well as their locally relevant identities as engineering students, Americans and non-Americans, ethical actors, and so on.

The methodological diversity in the approaches taken by Wood (2013) and Philip et al. (2018) is further reflected in Orlander Arvola (2014) who examines middle school classroom discursive practices during a lesson on human genitals. Drawing on practical epistemology analysis (Wickman, 2004), Orlander Arvola (2014) shows how the teachers and students co-constructed specific meanings through verbalizing, tacit or explicit acceptance of a prior utterance, and/or filling in the gaps and connections left unsaid in a prior utterance. The inclusion and exclusion of particular knowledges and their significance were outcomes of interactional negotiations between the teacher and the students. While the teachers' moves emphasized learning basic facts about human anatomy, students' wonderings connected them to their own experiences, blending gender and sexuality. Thus, "basic facts" reemerged in this discourse as contextual and imbued with cultural-political meaning. Linked to dominant ideologies, the facts-focused discourse also tended to center male anatomy and heteronormativity, with the discussion of female anatomy as derivative and deviating from male anatomy. Even with these reinscriptions of dominant ideology, Orlander Arvola shows that students' questions challenged hegemonic normalizations of gender and epistemology, creating a more expansive and tangled discursive space. Similarly, Hale (2015) shows how the status and identity of being a "special education" student was acknowledged, accepted, contested, and rejected through students who participated in cogenerative dialogue with their peers and teacher.

The distinctive contribution of Wood (2013), Hale (2015), Orlander Arvola (2014), and the work by Philip and his colleagues is showing *how* identity and ideology are co-constructed in interaction between participants within the particularities of context. To be clear, the theoretical underpinning of their work relies heavily on the prior contributions of critical theorists and critical feminist scholars. The novel contribution of this body of work is the development and deployment of methodological tools, such as micro-identities and ideological convergence, which empirically make visible and accentuate the dynamic processes through which identity and ideology are co-constructed. These detailed, microgenetic, and interactional examinations of the processes of co-construction are then poised to further nuance, contextualize, and complicate the theories on which they build. They caution us against the tendency to slip into claims that the historical, structural, and ideological aspects of power are simply embedded in the organization of a learning environment, that they

inherently exist in tools, resources, and human bodies and are waiting to be activated. Rather, in analyses, such as Philip et al.'s (2018) examination of nationalism within the context of an undergraduate classroom, these researchers empirically show how it is in interactions that the cultural and historical traces of power are rendered visible, remade, and/or challenged. This approach shifts the lens from efforts to change the macro-identities of students or the presumably stable ideologies of teachers and students to nuanced attention to the interactions between participants through which micro-identities and microcontestations of ideology emerge in spaces of learning.

Another set of articles in this category emphasized the co-constructed nature of disciplines, like mathematics and science. Rahm's (2007) analysis of conversations among teenage youth in a summer gardening program documented that male participants distinguished between different kinds of scientific work along racial lines and female participants constructed the differences in scientific work along gendered lines. Through these utterances, Rahm argues, the youths' own gendered and racialized selves in relation to science were constructed and made visible. Similarly, Archer et al. (2010) examined how in elementary school students' discourse about what counted as science, there emerged a distinction between science in elementary school and "real" or "grown-up" science. Students co-constructed the science that they did in school as "safe," "immature," and not real science. Such science was contrasted with real science that was dynamic, unpredictable, and involved taking risks (including physical risks) and was taught at higher grade levels or practiced by professional scientists. Drawing on poststructural theorizations of gender (Butler, 1990), Archer et al. (2010) argue that these discourses layer "school" versus "real" science with gendered meanings, with masculinity mapped more strongly onto real and grown-up science.

Complementing Rahm's (2007) and Archer et al.'s (2010) studies of how students conceived of science, Due (2014) examines the practices in a science classroom that positioned students differentially. Due illustrated how girls, in observed physics group work, tended to focus more on understanding, expressed uncertainty, and asked more questions, constructing themselves as responsible students but also putting them at risk for being positioned as less competent in physics. Boys, on the other hand, had a larger range of positionalities available to them, from an irresponsible student, to playful, to being a competent and competitive student in physics, and, as a result, their contributions were less frequently questioned by self or peers. While there were contestations to these positionalities in some groups, in most cases, they limited the ways in which female students could come to see themselves as competent physics learners or as having trajectories that allowed for more central participation in the physics community of practice (Lave & Wenger, 1991). Due (2014) argues that these cases illustrate that "theories concerning 'situated learning' (Lave & Wenger, 1991) must be supplemented with theories about power relations" (p. 457). Similarly, Archer et al. (2017) drew on critical discourse (Burman & Parker, 1993) and gender theory (Butler, 1990) to show how power is organized within talk and the social implications of particular constructions. They document how the everyday

actions that are celebrated or considered exemplary in the science classroom are often masculine and aggressive, demonstrating what they call "muscular intellect." The celebration of these performances legitimizes them, narrowing the possibilities for who gets to be seen as a science person (Carlone et al., 2014).

In a similar vein, Ideland and Malmberg (2012) compare the discourses that students from a Swedish urban middle school and a Swedish suburban middle school engaged in during same-gender focus group discussions on body and health. They note that the positionalities that were available and taken up by students in terms of being a good student were entangled with their conceptualization of gender performance. Girls at the urban school questioned the normative characterizations of body and health, resisted stereotyped notions of Muslim girls from immigrant and low-income families as weak and passive, and created and made available alternate versions of femininity through "othering" the stereotype.

These studies show local constructions of science and their alignments with dominant representations of race and gender in science rather than assuming the inevitability of gendered and racialized exclusion in science. While the resonance between the local construction of science and its hegemonic representation is disheartening in both studies, they problematize assumptions of top-down determinism and suggest the possibilities of localized constructions that are robust enough to mitigate or resist the effects of dominant ideologies.

Talk and action in science classrooms thus embody cultural understandings and norms of gender, class, and disciplinary identities and epistemologies, constituting the "doing" of specific aspects of identity (Butler, 1990; Paechter, 2007). These discourses simultaneously constrain and enable what participants can do and say, the positionalities available to them (Foucault, 1979), and, ultimately, who gets positioned by self and others as legitimately belonging in science (Carlone et al., 2014). Identity, thus, is not conceptualized as an internal sense of self but as constituted in and remade by interactions and participation in local cultural practices (Esmonde, 2009; Nasir & Hand, 2006).

Much of the work in this category examines shifts in identity and ideology across relatively short timescales. Notable exceptions, Gresalfi et al. (2009) and Carlone et al. (2015) show that microlevel interactions have the potential to sediment into more durable identities over time. In their analysis of competence, Gresalfi et al. (2009) shift the lens of analysis from an individual and individual traits to the social organization of a classroom by considering the system of competence that gets constructed as students and teachers negotiate the following:

> (1) the kind of mathematical agency that the task and the participation afford, (2) what the students are supposed to be accountable for doing, and (3) whom they need to be accountable to in order to participate successfully in the classroom activity system. (p. 52)

They thus bring attention to the "interaction between the opportunities that a student has to participate competently and the ways that individual takes up those opportunities" (Gresalfi et al., 2009, p. 50).

Carlone et al. (2015) study girls' identity development in elementary grade science classrooms. While they do not attend to micro-interactions in detail over very short timescales, they attended to "patterns of girls' discursive performances of femininity in school science from fourth to seventh grade" (p. 478). They collected field notes, interviews with students and teachers, and videos of classrooms. They analyzed these data for academic performances like "good student," and particular performances of femininity often associated with distancing from a scientific identity such as pleasing adults and making one self submissive or invisible. Their analysis honed in on one student, Mirabel, over the course of 3 years of schooling. They show how her identity shifted from being one of the class's "smartest science students" and from being actively engaged in Grade 4 to being constructed as "flighty" and a "social butterfly" whose interest in "girly stuff took [her] away from intellectual engagements" in Grade 5. By Grade 6, Carlone et al. argued that Mirabel was playing with a more "heterosexualized identity" and positioned herself as helpless and in need of assistance. In their assessment, by sixth grade, Mirabel played up heteronormative sexual performances and downplayed her academic side, using her agency to "walk away from her possibilities in science in favor of her primary social goal to fit in with peers" (p. 485). The authors situate these changes in the performances of Mirabel and other girls within "classroom organizational, ideological and interpersonal structures," particularly narrow constructions of who is good at science. They argue that Mirabel's fifth- and sixth-grade classrooms put severe constraints on Mirabel's agency, leaving her without a "viable academic/scientific subject position" that allowed her to still fit in, encouraging her to choose to be "more social and girly," a social position that afforded recognition from her peers and teacher.

Reading this body of work prompts us to examine how hegemonies of race, gender, and class (and other dominant power structures) are co-constructed within classroom interactions and "acquire" (McDermott, 1993) learners and/or the discipline through discourse and participation structures. They also present openings that have potential to disrupt these hegemonies. The articles in the next section take up the question of whether and how the organization of the learning environment more broadly reproduces and/or challenges these hegemonies.

Attending to the Organization of a Learning Environment

This set of studies is more diverse with overlapping attention to the organization of a learning environment. At one end of the spectrum are infrastructural elements that embody relationships of power. As an example, Archer et al. (2016) studied the design of particular exhibits at a museum and how students interacted with these spaces. Their discourse analytic approach looked for "how power is organized within (the boys') talk" to draw out "the social implications of particular constructions" (p. 451). Their analysis asked the following: "What is the talk doing? What is being normalized or defended? Where is the locus of power within a particular construction—whose interests are being asserted? Who or what is being othered? What is normalized or closed down?" (p. 451). In their data, Archer et al. identified

performances and tropes of masculinity and the ways in which they were supported or challenged by others. They attended to how these forms of masculinities existed in relationship to performances of science identity and intersections with classed and racialized discourses. Their analysis suggests that the design of the exhibits promoted masculine displays of "laddishness" by certain boys visiting the museum. In some cases, such performance of gender also opened up opportunities for the boys to engage in science discussions. Archer et al.'s (2016) analysis draws on poststructural gender theory to show how "hegemonic masculinity is normalized within the museum space," shaping who gets to do science in that space and how. Similarly, Dawson (2014) studied interactions between museum staff and visitors from low-income racial minority backgrounds within the context of the design of exhibits and the assumptions and practices embedded in museums. Through this examination, Dawson highlighted differences in the cultural, linguistic, economic, and social capital (Bourdieu, 1998) of the visitors and how they were co-constructed through assumptions built into the exhibits and modes of interaction. The organization of the learning space led to a form of symbolic violence (Bourdieu, 1990) that tended to exclude visitors from low-income backgrounds or made it more difficult for them to identify with the museum space.

Archer et al.'s (2016) analysis forefronts infrastructure such as the physical environment and the "stereotypically masculine objects in the museum" that emphasized competition and "afforded boys a platform from which to assert performances of hegemonic masculinity" (p. 468). The organization of a learning environment is not only physical, it also entails how the shared activity is locally structured to collectively address certain types of problems. Horn (2007) highlighted the problems of practice that teachers encounter and how they solve these problems in consultation with their colleagues. In particular, she showed how conceptions of students, mathematics as a subject, and teaching are all embedded and interactionally reconstructed in teacher's daily work. She explored how the conversational category systems at schools mediated the ways in which teachers took responsibility for students' learning at one school site and how they constructed students to be at the root of the problem at another school site. Methodologically, Horn studied the categorization of students and its relation to teachers' practices and their conceptions of their subject through a unit of analysis she termed *episode of pedagogical reasoning*—"units of teacher-to-teacher talk in which teachers exhibit their understanding of an issue in their practice" (p. 46). Horn's work shifts the focus from the presumed beliefs of individual teachers (and efforts to change them) to the collective meaning making that emerges from the everyday practices of teachers.

Related to Horn's (2007) problem of practices, Jackson's (2011) inquiry demonstrates the implications for students when sites of learning are organized such that knowledge and practices flow in one direction, particularly between sites with differential forms of power. In her study, Jackson extensively observed one student, Timothy, at home and eventually in his school context. At home, Jackson observed a collective effort on the part of Timothy's parents to arrange and rearrange situations for him to successfully complete his homework, given the consequences that noncompletion presented for him at school. Yet Timothy's teacher attributed his

challenges with homework first to a presumed disability and then to "coddling" on the part of his parents. Jackson argued that the student's shortcomings in the classroom were produced not only in the classroom but also through the teacher's unwarranted interpretation of what was happening at home. Jackson's study suggests the importance of examining how different sites of learning are organized and interact with each other.

The organization of a learning environment can also be relational. Bruna and Vann (2007) and Bruna (2010) suggest that a friendly relationship between the teacher and the students can allow students to interject with their ideas and questions, leading to the transformation of the activity system. Takeuchi (2016) takes on this theme more substantively. Takeuchi documents that when English language learners work with friends in small-group problem-solving activities, they had access to a wider range of roles, including that of an expert. In teacher-assigned groups, the same students were positioned as incapable and their contributions were often not recognized, which limited their opportunities to learn.

Differences in epistemologies and the values attributed to different practices also play a role in organizing a learning environment. Bruna and Vann (2007) and Bruna (2010) examine the experiences of immigrant middle-school students of Mexican origin in their science classroom. Focusing on a lesson on pig dissection, Bruna and Vann (2007) show how the framing of the lesson by the teacher was situated in the race and class divisions of the town whose main industry was a meatpacking plant with majority White administrators and majority Mexican immigrant workers. The teacher–student interactions, the structure of the activity, the tools involved, and the knowledges forefronted, reified this racial and classed framing. The organization of the classroom made it difficult for students to draw on their personal experiences and community knowledge as epistemic sources. These authors demonstrate through their analyses that power is never fully deterministic and that the intersectional nature of power allows students to position themselves and get positioned by others along multiple axes. For instance, Bruna (2010) further developed this analysis to show moments when the class's normative patterns were resisted and temporarily transformed by a student, who drew on his transnational cultural resources and his recognized proficiency in English.

As in Bruna (2010), many of the articles in this cluster (Andrée, 2012; LópezLeiva et al., 2013; Meacham, 2007; Puvirajah et al., 2012) show how shifts in the activity system allowed for the emergence of different positionalities and possibilities for authoring different selves. For example, LópezLeiva et al. (2013) showed how a shift in attending to and elaborating on English language learners' hybrid linguistic resources (from judging or dis-acknowledging them) allowed students to make sense of complex mathematical ideas around probability and to author identities as competent mathematics learners. In their study of a dual-language after-school mathematics program, they examined when students decided to work in mostly Spanish or English, the strategies they employed across these instances, and "patterns across groups in how the students' multidimensionality was accounted for and legitimized as well as how students and their facilitators participated [. . .] during probability

problem-solving tasks" (p. 924). Puvirajah et al. (2012) examined how the shift in the activity system from a science classroom to the context of a robotics competition reduced the power imbalance between students and teachers, opening up ways in which to participate that more closely mirrored professional science practices.

Resonant with articles in the previous category, Jackson and Seiler (2017, 2018) emphasized the co-construction of disciplines and identities. They draw on the figured worlds framework (Holland et al., 2001) alongside critical discourse analysis (Gee, 2011) to examine how students who enter postsecondary science through nontraditional journeys ("latecomers") struggle to find ways to achieve status as "good student" or "being good in science" in the classroom. They argue that the elitism of science as constructed in the figured world of the institution and the dominance of teacher-centered and sink-or-swim cultural models of learning made it more difficult for latecomers to science to author science identities. In the 2017 article, Jackson and Seiler highlight two cases where the "latecomer" student subverted the dominant models to gain status as a student and a science learner. In their 2018 article, they showed how a similar transformation in status and affinity to science could be achieved collectively by a group of students through online dialogue, by building solidarity, and by recognizing the value of asking questions.

Further problematizing static conceptions of disciplines, Rosebery et al. (2010) develop the construct of epistemological heterogeneity. They highlighted through their study of a class of third and fourth graders how classrooms are "spaces in which whole systems of meaning or ways of seeing the world come into contact with one another in both planned and unplanned ways" (p. 337). They drew attention to how "instructional encounters" can be designed with "the aim of fostering contact among varied languages and points of view to generate learning of disciplinary ways of seeing the world" (p. 351). Rosebery et al.'s theorization of learning as heterogeneous meaning making is resonant with Van Horne and Bell's (2017) study of the design of a high school biology classroom that engaged youth in culturally expansive epistemic practices of science. The design of the classroom provided youth with multiple entry points that supported the development of their disciplinary science identities and their possible future selves. Their analysis examined how particular subject positions became meaningful to participants within the setting they studied. Van Horne and Bell coded for how students "were positioned to engage in specific kinds of work over time, the kinds of persons that were related to that work, and a tracing of the self-reflection and social recognition work that unfolded over time" (pp. 452–453). They also paid particular attention to the outside expertise students brought to bear to disciplinary practices and how it was meaningful or not to their goals within the setting.

While the articles above problematize the exclusionary practices of "Western science" in schools, Bang and Marin (2015) and Marin and Bang (2018) examine the new possibilities that emerge when Indigenous ways of knowing are centered. Marin and Bang (2018) explored a Native American family's experience on a walk in an urban forest preserve and how learning unfolded in this place. They make "an argument for walking, reading, and storying land as a methodology for learning about and making relationships with the natural world" (p. 111). Their analysis is situated within

a deep recognition of the complex ecological challenges facing the globe. They suggest that making progress on these ecological challenges "requires attending to the microgenetic processes that give rise to human-nature relationships in activity and practice" (p. 113). Drawing on design-based work rooted in a framework of Indigenous ways of knowing, Bang and Marin's (2015) study of everyday parent-child interactions led them to argue that organizing learning environments so that they "expand the boundaries of reality and possible futures for students is both vital and possible" (p. 542). They argued that normative practices create moments of interaction that tend to reinscribe inequalities while demonstrating the political and ethical significance of reorganizing talk-in-interaction for practices such as "memory traces."

The articles in this section considered the organization of the learning environment as a whole, which includes the physical space, the available resources, the organization of social relationships, particular types of performances and recognitions, and access to resources. While the articles in the first section highlighted the moment-to-moment co-constructions of identities and ideologies, articles in this section take a slightly broader unit of analysis—the organization of the learning environment. They highlight how the mesolevel organization mediates the contact of micro-interactional processes with macrocategories and constructs. In the section below, we explicitly highlight a set of articles that focuses on how tools are used, adapted, and refashioned to exercise power.

Leveraging and Repurposing Tools

The set of articles in this category explored how representational, meditational, and discursive tools afforded opportunities and constraints through which power and learning were co-constructed. In particular, Rubel et al. (2016), Rubel et al. (2017), Hostetler et al. (2018), and Philip et al. (2016) explore how these co-constructions emerge within the context of new digital technologies. Rubel et al. (2017) and Philip et al. (2016) draw attention to how representations of data through maps are interpreted through ideological systems where space is highly racialized. They show how disciplinary meaning making about the data was integrally connected to students' meaning making about themselves as sociopolitical actors and about systems of power in which they lived and moved. Their analysis at the level of turns of talk—drawing from Goodwin's (2007) participation framework in the case of Philip et al. (2016) and Morris's (2013) map reading framework in the case of Rubel et al.—demonstrate the opportunities for disciplinary learning and learning about power that were afforded and limited by the use of the representations. These pieces add to a rich tradition of scholarship that has emphasized that tools and representations embody power and politics. They trace how these representations are leveraged and contested in interaction to co-construct opportunities for learning and meaning making about power.

Hostetler et al.'s (2018) work highlights the use of new digital tools to create representations that allow learners to take on the perspectives of others. Their agent-based computational models of ethnocentrism and racial segregation allowed preservice teachers to "discuss critical socio-political issues in the classroom without

forcing themselves to reveal their personal experiences or assumptions" (p. 145). They argue that once the learner locates themselves in the simulation, they identify with a certain type of agent and in turn construct the remaining agents as "others." By attending to the learning opportunities afforded through this set of tools and representations, the authors show the range of empirically informed discussions that learners engage in as they consider, through a process of objectification, the perspectives of the multiple agents in the simulation. Reasoning about the world of computational agents afforded opportunities for the learners to "build discourses that included critical perspectives, debate relevant conflicts, and develop nuanced understandings of the underlying socio-political-economic mechanisms that may be responsible for the emergence of ethnocentric behavior" (p. 140).

Emphasizing the importance of mediational tools, Lewis (2014, 2017) examined the construction of mathematical learning disabilities (MLDs). Based on her analysis of tutoring interactions with two students with MLDs, she showed that standard instructional representations most commonly used in mathematics classrooms are inaccessible for these students and thus co-construct the MLDs. She conjectured that the *re*-mediation (Gutiérrez et al., 2009) of tools to account for and build on students' understandings might expand learning opportunities for students with MLDs. Lewis's (2014, 2017) work demonstrates that an interactional analysis that focuses on the affordances and limitations of mediational tools for different students can elucidate the co-construction of forms of power such as ability and disability. With similar attention to mediational tools, Oliveira et al. (2014) examined how the representation of animal death in elementary school read-aloud sessions through lenses of predation or as an agentless outcome was viewed as natural and morally good, while representations of animal death as pollution-related were viewed as unnatural and immoral. Oliveira et al. demonstrated that representations of death mediate relationships of power between humans and other forms of life. Similarly, Oliveira et al. (2012) analyzed how "specific textual elements in the design of environmental dilemmas (types of prompts used, decision-makers' identities, statements of intentionality and outcome, moral complexity, values of nature, and social representation or cultural images of animals)" prompted either nonadversarial argumentation between students or argumentation that involved contestations over sexual identities, combative disagreement, and "conflict resolution on social rather than rational grounds" (p. 869). As another example, Buchholz et al. (2014) documented the culturally embedded gendered meanings of tools, which were reinscribed and renegotiated in interactions between students in an e-textile maker environment. Their analysis examines how the use of these tools opened up opportunities for students to learn and access positions of leadership.

A second category of tools that we examined was discursive in nature. These discursive tools, both social and disciplinary, were leveraged to co-construct status in classrooms and negotiate relationships of power among students and between teachers and students. Engle et al. (2014) trace the contributions of one student in a mathematics classroom. Through a framework that highlighted (a) the negotiated merit of each participant's contributions, and each participant's (b) degree of intellectual authority, (c) access to the conversational floor, and (d) degree of

spatial privilege, the authors demonstrate that influence in argumentation emerged dynamically through social interactions. Their analysis showed that while the normative quality of the focus student's arguments was lower than that of his peers, his arguments garnered more influence because of his perceived intellectual authority and his ability to "command the interactional space and conversational floor" (Langer-Osuna, 2017, p. 240; see also Langer-Osuna, 2015, 2016).

Similarly, Bishop (2012) closely examined the discourse patterns in small-group interactions. Her framework draws attention to (a) using an authoritarian voice, (b) making statements of superiority or inferiority, (c) using face-saving moves, (d) building solidarity and providing encouragement, and (e) controlling problem-solving strategies. Her analysis of two students, Teri and Bonnie, showed that through Teri's "control of discourse at the microlevel and their repeated and joint positioning of Bonnie as mathematically incapable with little to contribute, the girls enacted their respective identities of 'smart' and 'dumb'" (p. 66). Bishop's analysis shows how microlevel patterns in students' discourse shaped the mathematical identities they enacted.

Distinct from Engle et al. (2014) and Bishop (2012), Schoerning et al. (2015) documented the power asymmetry between the teacher and the student by attending to "language markers related to power and agency, including both non-grammatical factors such as tone and tempo of speech as well as the characteristics and qualities of that speech's dialog" (p. 244). They show how it was ameliorated over time, in the case they studied, through "an immersion approach" to argument-based inquiry, where "students develop questions, design experiments, gather data, and generate evidence to support claims that address their initial questions" (p. 254). Schoerning et al. showed that by "actively inverting some of the conventions of formal language" (p. 256), teachers can create new avenues for access and power for their students and engage them as stakeholders who are more able to engage in argumentative aspects of disciplinary negotiation. Highlighting intersections of power, Enyedy et al. (2008) showed the unintended consequences of the practice of revoicing students' contributions in a multilingual classroom and how this discursive tool operated at the intersection of linguistic and racial forms of power to inadvertently marginalize the African American students in the class.

Bridging the multiple tools across both categories, Vossoughi (2014) made an explicit link between artifacts developed in a learning environment and the deepening of the collective analysis of social problems in her study of an educational setting designed for high school–aged migrant students. She attended to how "social analytic artifacts"—"tools or habits of mind that deepen and propel the collective analysis of social problems"—were made and appropriated in real-time talk and interaction (p. 353). She analyzed "how classroom discourse, printed texts, and social relations created an environment where social analytic artifacts were codeveloped and appropriated over time" (p. 353).

Collectively, these articles draw attention to tools as imbued with power and with the potential to be contested and repurposed for different goals. Rubel et al. (2016), Rubel et al. (2017), Hostetler et al. (2018), and Philip et al. (2016) made evident the

emergent possibilities and challenges of new digital tools and representations as they enter learning environments. Lewis (2014, 2017), Oliveira et al. (2014), and Buchholz et al. (2014) reminded us of the ways in which power is deeply embedded in the tools and representations that mostly go unquestioned as well as the importance of remediating them toward more equitable and just purposes. Engle et al. (2014), Bishop (2012), and Schoerning et al. (2015) highlighted how discursive tools are deployed constantly to enforce and challenge power and status. Finally, Vossoughi (2014) explicitly attends to how tools can be codeveloped toward collective social analysis and political learning. Collectively, these articles remind us of the dynamic nature of the organization of learning environments and of learners' agency in these spaces. In these articles, tools, which could be linguistic tools, digital technologies, representations, etc., become the locus or site where macrocategories and constructs are entangled with microlevel interactions.

DISCUSSION

In his article, "Researching race in mathematics education," Martin (2009) pointed out a troubling contradiction between the conceptualization of race across fields of inquiry. His critique of undertheorization and overly simplistic methods of analysis echo a recurring theme across the articles we reviewed—the risks of assuming the salience of labels and categories a priori in an analysis, without attention to how they take and give meaning through interaction. Martin's assessment can be extended more broadly:

> Although [group-based identities and categories] are characterized in the sociological and critical theory literatures as socially and politically constructed with structural expressions, most studies of differential outcomes in . . . education begin and end their analyses . . . with static . . . categories and group labels used for the sole purpose of disaggregating data. (p. 295)

The articles we reviewed underscore the steadily growing scholarship in the learning sciences, mathematics education, and science education that has seriously engaged with sociological and critical perspectives to conceptualize and study power. Acknowledging that we included an additional criterion of microgenetic and interactional analysis to Martin's call, the relatively small number of articles we identified, however, and their complete absence or near absence in leading journals in the field speak to the persistence of the underlying shortcoming Martin named in 2009. Yet they also highlight a burgeoning significant subfield that we term *critical interaction and microgenetic analysis*.

It is not uncommon that claims made in rich qualitative studies, such as those we examine here, are minimized as isolated cases (see Flyvbjerg, 2006). By bringing this set of articles together, this chapter provides collective epistemic and empirical weight to claims of power and learning as co-constituted and co-constructed through interactional, microgenetic, and structural dynamics. Reading across the thematic areas we identified, the assembled literature points to the importance of *simultaneously* holding the following analytical commitments in critical interaction and microgenetic analysis:

1. Attending to and foregrounding variability in learners' identities and their ideological stances.
2. Establishing links between moment-to-moment variability in learners' identities, the ideological stances they take, and the forms of relative durability in these constructs over time, place, and settings.
3. Emphasizing the co-construction of power, identity, and ideology through participants' interactions, and how disciplines such as mathematics and science are co-constructed as ideological (racialized, gendered, classed, etc.) through interactional processes.
4. Examining how dynamics of power, identity, ideology, and disciplinary sense making are afforded or constrained by (a) the design of the learning environment, (b) the propensities of architecture and infrastructure to promote particular interactions, and/or (c) the relationships that are likely and that are possible in a setting.
5. Seeking an understanding of the continuities and discontinuities of identities and ideologies in learners' lives across multiple sites.
6. Analyzing how representational and discursive tools are used, contested, and/or repurposed by learners as they negotiate powered relationships.

We certainly resonate with Martin's (2009) call for the learning sciences, mathematics education, and science education to more fully engage critical social theory. And, we reverberate with Nasir and Hand's (2006) provocation for how theories of learning, particularly sociocultural theories, can contribute to social theory. While relatively small in size, the body of scholarship we reviewed begins to illustrate the possibilities of such integration. The microgenetic and interactional analyses bring into relief the particularities of context, making visible the limits, edges, and horizons of more abstracted theories of power. They add nuance to, contextualize, and complicate the theories of power, identity, and ideology on which they build.

In this review, we put in conversation with each other various bodies of research on learning that integrated methods of microgenetic and/or interaction analysis with frameworks of power. Collectively, these articles provide a nascent empirical basis for understanding the dynamic relationship between macrolevel structures and ideologies and microlevel interactions: The macrolevel structures and ideologies afford and constrain microlevel interactions where people are always repurposing tools, reimagining themselves, renegotiating relationships, and improvising with practices and ideologies; these microlevel repurposings, imaginings, negotiations, and improvisations cumulatively shape the local emergence of ideologies and structures. Taken together, this body of scholarship makes visible the limitations of assuming the stability of macrolevel identities and ideologies in spaces of learning or of imposing them onto an environment based solely on post hoc interviews or summative narrations of observations.

As a group, the articles illustrate that interactions, the myriad microtransactions among people and between people and their environments, are sites for "becoming," where identity and ideological work happen. In learning environments, microgenetic

processes of identity and ideology are about becoming particular kinds of learners and particular kinds of persons in the world: gendered, raced, classed, (dis)abled, and so on. If race, class, gender, competence, ability, sexuality, disciplinary, and/or professional identity are all constructions locally emergent from culturally historically situated microlevel interactions, then, taken together, these articles suggest that (a) deep engagement with intersectionality (Collins & Bilge, 2016) is essential to better understand power in interaction and (b) a fine-grained attention to power in interaction will further the theoretical and methodological horizons of intersectionality. While the articles we reviewed conceptualize ideology and identity as emergent constructions, only a few (e.g., Gamez & Parker, 2017) took an explicit analytical attention to intersectionality—a pressing area for future work.

The articles reviewed also underscore that all interactions in learning environments are political and ethical, and all learning environments are sites of politics and ethics. Taken together, the articles give added meaning to the claim that all teaching and learning are political, ethical, and ideological, accentuating that each moment of teaching and learning is consequential as teachers and students continually and jointly renegotiate power and possibility in every interaction (Philip, 2019). This recognition alerts us to the need for a more elaborate toolkit of attentional, linguistic, and interactional repertoires to collectively co-organize spaces where participants are more likely to engage "epistemological heterogeneity" (Rosebery et al., 2010) and "ideologically converge" (Philip et al., 2018) toward more just and equitable interactions.

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