

## Chapter 8

# Teaching Practices That Support Student Sensemaking Across Grades and Disciplines: A Conceptual Review

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*Sensemaking entails being active, self-conscious, motivated, and purposeful in the world. It is an activity that is always situated within the cultural and historical contexts in which we interact with others and with the aid of tools. In this chapter, we contrast everyday sensemaking with academic sensemaking and treat academic sensemaking in a disciplinary-specific manner, exploring how teachers engage students in academic sensemaking within the domains of mathematics, science, history, and literature. Consistent with the focus of this volume, which is designed to feature teacher practice, the goal of our chapter is to explore the practices in which teachers engage when the purpose is to position students as sensemakers and create a classroom culture that provides the resources and contexts to develop skill with academic sensemaking. Our analyses revealed the broad range of practices necessary to characterize the enactment of instruction that is designed to teach and promote sensemaking, as well as the multitude of purposes those practices served. To explicate the domain-specific nature of teacher practice, we analyzed selected studies in which the researchers provided significant detail regarding teachers' practices. We conclude that sensemaking is a productive lens for investigating and characterizing great teaching.*

Observing a row of sunflowers, one shorter than the next, a 4-year-old commented, "I think I know how this happened. The first flower got more sun and grew very tall; it made shade for the next flower, which grew tall, but not as big. Each flower made shade for the next flower." In a conversation about how we have day and night, one 5-year-old suggested, "At night the sun goes down into the water and the

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stars come up in the sky,” while another proposed, “God makes day and night.” Each of these illustrates young children engaged in sensemaking. While we elaborate on a definition of sensemaking below, the general features of sensemaking include being active, self-conscious, motivated, and purposeful in the world. It is possible to “learn” without making sense; we overhear our university students alluding to this when they muse about “learning for the test,” and hoping that the learning “sticks” for the next 24 hours.

“Sensemaking” figures prominently in several literatures. It has a long history in organizational studies where it was introduced by organizational theorist, Karl Weick. Weick appealed to sensemaking to explain how the meanings that both inform and constrain identity and action in organizations come to be. He wrote, “Sensemaking is what it says it is, namely, making something sensible” (Weick, 1995, p. 16). Weick and his colleagues (Weick, Sutcliffe, & Obstfeld, 2005) propose that people organize to make sense of equivocal inputs and “enact this sense back into the world to make that world more orderly” (p. 410). The child who explains the day/night cycle in terms of the “sun goes into the water” may well be drawing upon experience watching the sun appear to disappear on the horizon of a body of water, or hearing her parents say, “Be sure you are back before the sun sets,” and a “setting sun” probably seems far more orderly—and believable—than the earth spinning at 1,000 miles per hour, always half in and half out of the sun’s rays.

Klein, Moon, and Hoffman (2006) distinguish sensemaking from creativity and curiosity, both of which—they argue—are aspects of sensemaking to the extent that creativity and curiosity can drive sensemaking but are not synonymous with sensemaking. Furthermore, they distinguish sensemaking from comprehension, proposing that comprehension relates to understanding specific stimuli (such as words and chunks of text), while sensemaking pertains to complex events (such as plant growth and the day/night cycle, mathematical problems, multiple accounts of historical events, or literary works). Klein et al. conclude that mental modeling is perhaps closest to sensemaking since mental models can be used to explain events.

We were motivated to prepare this review because we believe that an important orientation that successful teachers bring to their work is the presumption that their students are constantly engaged in making sense of the world. While student sensemaking may not always lead to canonical explanations (e.g., for the day/night cycle), humans use what they observe and experience to make sense of their worlds, the past, and literature. We further maintain that *making sense is a social process*, that is, sensemaking is an activity that is always situated within the cultural and historical contexts in which we interact with others and with the aid of tools. As Bruner and Haste (1987), in their volume, *Making Sense*, explain,

The set of frameworks for interpretation available to the growing individual reflects the *organizing consciousness of the whole culture*—in other words, it is difficult, if not impossible, for a child to develop a concept that does not have an expression within her culture of origin . . . the development of concepts will depend on the available resources within the culture. (p. 9)

Vygotsky, in *Thinking and Speech* (1934/1987), made a helpful distinction between the everyday, or spontaneous, concepts that arise from individuals' sensemaking as they interact with the world and those that are promoted in the context of school instruction. School instruction is typically designed to foster a mode of thinking that is characterized by generality, systemic organization, conscious awareness, and voluntary control. Vygotsky (1934/1987) further argued that, while everyday concepts are spontaneously appropriated as the learner engages in social interaction in the context of joint activity experienced in one's immediate community (e.g., family), "scientific" or formal concepts result from the deliberate and systematic instruction typical of educational settings. For the remainder of this chapter, we will contrast *everyday sensemaking* with *academic sensemaking*. Furthermore, we will treat academic sensemaking in a disciplinary-specific manner, exploring how teachers engage students in academic sensemaking within the domains of mathematics, science, history, and literature.

Consistent with the focus of this volume, which is designed to feature *teacher practice*, the goal of our chapter is to explore the practices in which teachers engage when the purpose is to position students as sensemakers and create a classroom culture that provides the resources and contexts to develop skill with academic sensemaking. One intriguing feature of this problem space is that learners do not leave their everyday sensemaking at the school door. Hence, teachers negotiate the everyday sensemaking in which learners engage—which may be more or less continuous with the formal sensemaking to which they are introducing students—with academic sensemaking. Our review was designed to explore what we know about the specific ways in which teachers engage in this negotiation and how it compares and contrasts as they teach within specific domains.

## METHOD

To prepare this chapter, we undertook a conceptual review of the literature. Kennedy (2007) made a useful distinction between a *systematic review* and a *conceptual review* of the literature. A systematic review typically focuses on a specific empirical issue that is often framed as a cause and effect question; examples might be the following: What effect(s) does collaborating with other learners have on students' sensemaking? What effect(s) does prior knowledge have on sensemaking? In pursuit of specific answers, researchers conduct an exhaustive review of the literature seeking evidence that might speak to the question(s) guiding the review. A *conceptual review*, in contrast, is designed to yield new insights; exploring, for example, how the study of a topic has been represented in the literature; what approaches have been used in its study; what areas of contest are emerging. This is the approach that we have taken in our review; we cast a broad net, beginning with programs of research with which we were familiar, as well as using search terms related to sensemaking, consulting Google Scholar, and doing ancestry searches of reference lists. We searched for programs of research that investigated *how teachers support learners to engage in sensemaking*. We purposefully sampled across research in the teaching of science, mathematics, history, and literature since one of the questions guiding our review is

how sensemaking is construed and supported by particular teacher practices across disciplines. To be included in our review, the research had to attend to both the teacher and learner. This means that a large literature that focuses exclusively on learners as sensemakers was not included in our review. We analyzed each article to identify (a) what sensemaking looks like in the research, (b) the context of the research, (c) what the researcher studied about the relationship(s) between teacher practice and student sensemaking, (d) the methods used, (e) the codes/rubrics for characterizing teacher practice, (f) the findings, (g) the implications for teacher learning/teacher development, and (h) implications for future research.

### **HOW IS ACADEMIC SENSEMAKING REPRESENTED IN THE EDUCATION LITERATURE ON DISCIPLINARY TEACHING AND LEARNING?**

From a disciplinary perspective, the purpose of schooling is to apprentice students into the ways of thinking, knowing, talking, and engaging in inquiry that are consistent with the disciplines. In their conceptual meta-analysis, Goldman et al. (2016) identified five core constructs useful to characterizing knowledge across disciplines: (a) epistemology—that is, beliefs about the nature of knowledge and the nature of knowing; (b) inquiry practices/strategies of reasoning; (c) overarching concepts, themes, and frameworks; (d) forms of information representation/types of texts; and (e) discourse practices, including the oral and written language used to convey information.

To illustrate, when learning history in a discipline-specific manner, students are supported to experience history as a process of investigation. Students construct interpretations and arguments of historical events as they read primary, secondary, and/or tertiary texts, attending to the perspective of the authors, the contexts in which the texts were generated, and the ways in which the texts corroborate, or fail to corroborate one another (Bain, 2006; Lee, 2006).

Similar to history, argumentation is core to scientific inquiry. Investigations in which one collects and analyzes data, or interprets data that have been collected by others, are used to generate and test explanations for scientific phenomena (Chin & Osborne, 2010).

Kilpatrick (2001) identified five strands of mathematical literacy that support sensemaking

(a) conceptual understanding, which refers to the student's comprehension of mathematical concepts, operations, and relations; (b) procedural fluency, or the student's skill in carrying out mathematical procedures flexibly, accurately, efficiently, and appropriately; (c) strategic competence, the student's ability to formulate, represent, and solve mathematical problems; (d) adaptive reasoning, the capacity for logical thought and for reflection on, explanation of, and justification of mathematical arguments; and (e) productive disposition, which includes the student's habitual inclination to see mathematics as a sensible, useful, and worthwhile subject to be learned, coupled with a belief in the value of diligent work and in one's own efficacy as a doer of mathematics. (p. 107)

Finally, in literary reasoning, readers draw upon a repertoire of beliefs, experiences, rhetorical knowledge, and knowledge of literature to engage in argumentation about the meanings of literary texts (Lee, Goldman, Levine, & Magliano, 2016). With these brief characterizations reflecting academic sensemaking in a broad sense, we turn to specific studies of academic sensemaking within each discipline.

### Sensemaking in the Teaching of Science

Sensemaking in the natural sciences has a significant kinship with sensemaking more generally. In contemporary discussions regarding the conduct of science, philosophers of science acknowledge that what is observed is influenced by what the observer *knows* and *how the observer chooses to look*. Consistent with the characterization of Goldman et al. (2016), Duschl (2008) urged that science instruction focus on

*the conceptual structures and cognitive processes used when reasoning scientifically, the epistemic frameworks used when developing and evaluating scientific knowledge, and the social processes that shape how knowledge is communicated, represented, argued, and debated.* (p. 277)

The literature that we reviewed specific to research in science was consistent with this call. Hogan, Nastasi, and Pressley (1999) studied eighth-grade students constructing mental models specific to the nature of matter and phase changes, as well as building explanations from evidence. In fact, explanations and argumentation were integral to all of the research that we reviewed in science. For example, Engle and Conant (2002) traced the development of an argument as a reflection of disciplinary engagement with a class of fifth graders, investigating how animals survive, in a Fostering a Community of Learners classroom (Brown & Campione, 1994). McNeill and Pimentel (2009) focused on the dialogic process by which students made sense of data for the purpose of generating claims and critiquing those claims and justifications. Their research, conducted with secondary students, focused on evaluating claims specific to climate change. Manz (2016) studied the activity of third-grade students constructing and critiquing claims and the evidence that supports those claims; one of her goals was that students see evidence as open to interpretation. Specifically, the students were investigating the influence of environmental conditions on plant growth. Herrenkohl and Cornelius (2013) investigated the implementation and outcomes of an application called SenseMaker, which was designed to support fifth-grade students' engagement in scientific and historical argumentation. Specific to science, the students were supported to understand the relationship among predictions, evidence, and theories; furthermore, they were supported to develop and revise theory in the service of providing an explanation for a scientific question (i.e., Why do objects sink or float?). Their goal was to communicate that sensemaking in science is undergirded by creating sound arguments.

In each of these examples, sensemaking was a social process; the purpose of which was to engage students in generating and evaluating claims that explain scientific phenomena.

### **Sensemaking in the Teaching of Mathematics**

A review of the instructional literature in mathematics reveals not only areas of overlap with teaching and learning in science but also distinctive features. One of the areas of overlap is the expectation that students assume an exploratory stance toward the subject matter. For example, Silver and Stein (1996), in an effort to move away from drill and practice in mathematics teaching, designed tasks that would engage students in constructing meaning through the application of important mathematical concepts, symbols, and rules. Similar to explanatory work in science, middle school students in their research were expected to explain and justify their solutions to mathematical problems to others. An extension of this research in Stein, Engle, Smith, and Hughes (2008) documented teacher mediation of mathematical discussions in which students constructed and evaluated their own and others' mathematical ideas. Similarly, Pape, Bell, and Yetkin (2003) designed instruction in which middle school students analyzed mathematical problems (e.g., using multiple representations of algebraic equations), critically examined and justified their own mathematical reasoning, compared it with their classmates, and justified (or modified) their own reasoning. Distinguishing the instruction designed by Pape and colleagues was attention to what the researchers referred to as *self-regulating behaviors and attributions*, in which students named and described the strategies in which they were engaged that were critical to accomplishing the mathematical task; these strategies were documented and discussed. In this example, the teacher communicated to the students that the processes used in mathematical sensemaking are as important as the solutions themselves. Maher and her colleagues have conducted a program of research designed to explore how mathematical reasoning develops over time, with a particular focus on the features of the context, including the problems and discourse patterns, that engage students in mathematical sensemaking (e.g., Maher, 2005; Mueller, Yankelwitz, & Maher, 2014; Powell, Francisco, & Maher, 2003). In their research, sensemaking entails using reasoning to compare fractions, find equivalent fractions, and use Cuisenaire rods to perform operations on fractions. While the science community focuses on practices, such as making evidence-based claims, analyzing data, and explaining phenomena, the focus of the mathematics community appears to be on the processes of mathematical sensemaking.

### **Sensemaking in the Teaching of History**

To illustrate the features of sensemaking in history instruction, we drew heavily from the program of research by Monte-Sano and her colleagues with middle and high school students (e.g., Monte-Sano, 2008, 2011; Monte-Sano, De La Paz, &

Felton, 2014). In this program of research, the focus was on historical reasoning through the activity of reading and interpreting historical text in order to construct written historical arguments. Drawing on Wineburg's (1991) study of expert historians, Monte-Sano and her colleagues emphasized the following processes: (a) sourcing (i.e., noting authors of historical documents, as well as their intentions and assumptions), (b) corroborating (i.e., comparing multiple historical documents), and (c) contextualizing (i.e., situating the historical document in the time and place in which it was created). Particularly important to this review is the emphasis that Monte-Sano, referencing Bereiter and Scardamalia (1987), placed on writing as an opportunity for learners to transform knowledge already in the mind; in other words, to make sense of what is "known." Monte-Sano argued that writing is integral to sensemaking in history because as learners write, they learn how to use and frame evidence; they have the opportunity to explore biases in sources, compare and situate evidence, and take into account different perspectives on events.

Investigating a curriculum called *Reading Like a Historian*, which was designed to support secondary students to read and interpret historical documents, Reisman (2012) similarly drew upon the disciplinary-specific practices identified above. One contribution that Reisman made to the sensemaking literature is her application of Wineburg's (1994) expansion of the Kintsch situation model framework (Kintsch, 1986). Rather than a single representation, Wineburg (1994) explains that historians construct three representations: the representation of the text, which is historically contextualized and can prove "slippery" given the nature of language; the representation of the event, which includes the actors and their motivations; and the representation of the subtext, which enables the reader to make judgments about the authors' intents and biases. Reisman's curriculum calls attention to the intertextual nature of historical reading and the constructed nature of historical accounts. Students were expected to engage in historical inquiry by (a) building background knowledge to contextualize and make sense of historical documents, (b) reading and interrogating multiple historical accounts, and (c) constructing knowledge by reconciling those accounts. The students were supported to construct multiple representations of texts through explicit strategy instruction in historical reading strategies (sourcing, contextualization, close reading, corroboration) and by responding to guiding questions related to the strategies to interrogate the historical accounts. For example, students used a *historical reading strategies* chart, which posed questions such as the following: What words or phrases does the author use to convince me that he/she is right? How does this document make me feel? What is the author's point of view? What else was going on at that time when this was written? What do other pieces of evidence say? The questions on the chart were designed to support students to construct representations of the text, event, and subtext as they engaged in historical inquiry. In this manner, historical sensemaking is both a layered and recursive process in which the reader modifies their model of the historical event as they encounter different documents. Recall that

Herrenkohl and Cornelius (2013) studied both scientific and historical sensemaking. The SenseMaker app for history (in contrast to science) engaged students in critically considering the sources of historical accounts, cross-checking of sources, and being open to uncertainty as they engaged in historical inquiry.

### Sensemaking in the Teaching of Literature

As one might anticipate, there is a broad literature that we could draw upon when considering sensemaking in the teaching of literature, given the parallels between comprehension and sensemaking. We limited ourselves to four programs of research that make unique contributions to this literature, beginning with the work of Aukerman. Aukerman (2007, 2013) distinguished three forms of comprehension pedagogy. The first she referred to as *comprehension-as-outcome* pedagogy, which she proposed emphasizes getting the meaning “right.” The second she called *comprehension-as-procedure* pedagogy, which she characterized as teaching students to do the “right” things while reading; for example, engage the use of strategies such as inferring, summarizing, and visualizing. She identified the third as *comprehension-as-sensemaking* pedagogy, which is pedagogy that values the actual meanings readers make of text, regardless of “rightness.”

Consistent with the definitions of sensemaking that we explored in the introduction, comprehension-as-sensemaking acknowledges the active exploration of possibilities for meaning and is a creative process. Consistent with contemporary definitions of comprehension (e.g., “the process of simultaneously extracting and constructing meaning through interaction and involvement with written language,” RAND Reading Study Group, 2002, p. 11), Aukerman maintained that sensemaking is something that all readers do, but that teachers do not always treat this intellectual activity as generative if they are not teaching from a *comprehension-as-sensemaking* orientation. Aukerman further distinguished two forms of comprehension-as-sensemaking pedagogy, *expressivist*, which emphasizes surfacing student interpretations, and *dialogic*, which seeks to juxtapose and engage with students’ varying understandings through dialogue. Aukerman (2013) elaborated,

Dialogic comprehension-as-sensemaking pedagogy is not a matter of simply nurturing and celebrating student understandings, but rather of engaging students in dialogue about text in which understandings are transformed through encountering the understandings of others; even when students read alone, they will be engaging with a plethora of possibilities as they make sense of text. From a dialogic perspective on comprehension-as-sensemaking, then, neither a text’s meaning, nor the way in which a student arrives at meaning for a text, are predetermined: they are surprises, to use Matusov’s (2009) term, that unfold in refraction with other voices that are also working at sensemaking (Bakhtin, 1981). (p. 7)

The dialogic nature of teaching comprehension as a sensemaking process is also featured in the research of Lee (2006), whose orientation to the teaching of literary interpretation is referred to as *cultural modeling*. In her instruction, Lee drew heavily on the cultural resources (including language, cultural referents, and cultural values) of the secondary students she was teaching. The focus of the dialogic instruction was

on the reasoning in which the students engaged as they collectively interpreted text. Among her contributions to the literature is her elaboration on the cultural and linguistic tools that students bring to sensemaking with text.

The research of Grossman, Loeb, Cohen, and Wyckoff (2013) and Wolf, Crosson, and Resnick (2006) is illustrative of sensemaking instruction that focused on *sense-making processes*. Grossman et al. (2013) sought to identify the teaching practices that were characteristic of teachers who were more effective at supporting literary reasoning and literacy analysis. Drawing upon the Protocol for Language Arts Teaching Observation (PLATO), they discerned that explicit strategy instruction distinguished the practice of more effective teachers. These teachers modeled and provided guided practice in the use of approaches to engaging in sophisticated literary analysis, reading comprehension, and writing. Similarly, Wolf et al. (2006) investigated pedagogy that made explicit the high-level thinking that facilitates sensemaking with the active use of prior knowledge and engagement in activity that promotes getting to the underlying meaning of text.

Thus far, we have examined the ways in which sensemaking is represented as the focus and means of instruction across the teaching of science, mathematics, history, and literature. While there are many features that overlap, there are unique features as well that reflect the tools and norms of the respective disciplines, as well as the pedagogical orientation of the researcher. In the next section of this chapter, we turn to investigations of teachers' practices in these instructional contexts and what they reveal about the efficacy of teacher practices specific to supporting student sensemaking.

### EXPLORING SPECIFIC TEACHER PRACTICES IN SENSEMAKING INSTRUCTION

Lampert (2010) defined teaching practice by drawing a distinction between *having an idea* and *carrying out that idea*; the carrying out of the idea being integral to practice. An important caveat in our discussion of instructional practice is that—as Bruner (1966) noted—any discussion of instruction is, in fact, a discussion of both curriculum and pedagogy. As the descriptions above suggest, the curricula that were being investigated were intended to engage students in sensemaking. Given that the role of teachers is to enact the instructional discourse, as well as mediate the environment in which instruction occurs (Cohen & Ball, 2001), it is important to examine the teachers' practices in the context of the sensemaking curricula.

Before exploring the specific practices, we want to note the general character of the research methods used across the studies we reviewed. With few exceptions, the research was qualitative in nature and typically conducted with a single teacher or a small set of teachers; one exception is the research by Grossman et al. (2013), in which the participants were 24 teachers in 9 middle schools; another exception is the quasi-experimental research by Reisman (2012), in which the participants included five treatment teachers. Typically, the data were gathered with the use of classroom observations and video (e.g., Herrenkohl & Cornelius, 2013; Hogan et al., 1999),

which was transcribed and coded, drawing upon extant and new schemes (e.g., Manz, 2016; McNeill & Pimentel, 2009). In a few instances the data were used descriptively to construct case studies (e.g., Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001) or comparative case studies (Herrenkohl & Cornelius, 2013; Monte-Sano, 2008). Researchers occasionally engaged in microanalyses of classroom conversation and linguistic practices (e.g., Aukerman, 2007; Lee, 2006). Observations were frequently supplemented by interviews (e.g., Cervetti, DiPardo, & Staley, 2014) and, occasionally, teacher artifacts (such as the planning documents used in Pape et al., 2003) or student artifacts (e.g., Monte-Sano, 2011; Silver & Stein, 1996). In most cases, the researchers worked very closely with the teacher(s), or were, themselves, the teacher.

While we refer to teacher “practice,” the overarching practice across all of these studies was *engaging in discussion*; hence, many of the findings were reported in terms of discourse moves. This is consistent with the theoretical orientation with which we began this chapter; language plays a pivotal role in sensemaking instruction because it provides the means for learners to interact with others, to compare and contrast their thinking, and to negotiate meaning making.

However, there were additional practices that cannot be captured in terms of discourse; for example, making decisions about what resources to provide the students or making decisions about the sequencing of the problems presented to the students, or presenting multiple representations of a problem.

We begin with a characterization of teacher practices across the broad literature for the purpose of identifying commonalities in teachers’ practices that can be discerned by looking across the studies. Then, because it was not possible to do justice to the full range of teacher practices using a generic approach, we consider the disciplinary-specific nature of the practices.

### **General Teaching Practices Associated With Supporting Sensemaking**

To answer the question, “What are the general teaching practices associated with supporting sensemaking?” we constructed a table in which we arrayed the findings from each of the 24 instructional studies that we analyzed. We then examined those findings for patterns in the five major categories that emerged from this analysis.

The most frequent category of practice was *teacher questioning*; however, the features of questions that were determined to be relevant to describing teacher practice varied in significant ways. For example, teacher questions served a broad range of purposes, including extending and clarifying student thinking (e.g., Hogan et al., 1999) and requesting additional information (e.g., eliciting reasoning and justification for responses, e.g., Pumtembeker, Stylianou, & Goldstein, 2007). Teacher questions were characterized as having different features within and across studies; for example, they were described in terms of their “openness” with more open questions yielding more productive discussion (e.g., McNeill & Pimentel, 2009). They were

described in terms of their degree of refinement, with productive questions moving toward greater refinement (e.g., Manz, 2016) and being driven by specific conceptual goals (e.g., Pumtembeker et al., 2007). They were also described in terms of how the questions were informed by student contributions, with more productive questions building from student contributions (e.g., Cervetti et al., 2014).

The second category of practice was *making connections*. This seems especially appropriate to the activity of sensemaking if one subscribes to the notion that—in the activity of sensemaking—we bring sense to ideas that we already know at some level. The purposes making connections served included making connections between activities and concepts (e.g., Monte-Sano et al., 2014; Pumtembeker et al., 2007), making connections among students' ideas (Stein et al., 2008), making connections among ideas that emerged over time (e.g., Silver & Stein, 1996), and making connections among epistemic levels (Manz, 2016). In order to engage in the practice of making connections, teachers in these sensemaking studies were also observed to track knowledge development, monitoring for evidence of required knowledge (e.g., Hogan et al., 1999), and supporting students to build background knowledge to support sensemaking (Monte-Sano et al., 2014). Tucked within this category is the practice of revoicing (O'Connor & Michaels, 1993). Revoicing has been used to characterize the discourse moves that teachers make in which they make an inference about a student's contribution to the discussion that serves to bring that student's contributions into alignment with the academic task and, in the process, serves to position the student as a contributor to the academic discourse.

The third most frequent category of practice was *increasing challenge*. This was accomplished in multiple ways, some of which were represented in the teachers' talk, for example, pressing students to elaborate on their responses (Henningsen & Stein, 1997), promoting higher levels of reasoning (e.g., Lee, 2006), or sustaining pressure for students to continue their exploration of a context or problem (e.g., Aukerman, 2007). This practice was also demonstrated when teachers progressed to more challenging tasks or sequenced the problems or tasks in the curriculum with an eye to the intellectual demands (e.g., Monte-Sano, 2011).

There were a number of practices that served to *enculturate* students into the activity of engaging in sensemaking conversations. For example, establishing the norms and conditions that would be necessary for productive classroom conversation (e.g., Engle & Conant, 2002), communicating the disciplinary-specific standards by which knowledge claims are made (we elaborate on this below), and giving authority to students, which in some cases, was associated with the teacher refraining from assuming the role of evaluator (e.g., Aukerman, 2007).

A final category of practice was *differentiating instruction*. This practice was enacted in an array of ways. Examples include spending additional time with students who were struggling, alternating whole-class instruction with working in small groups or individually (Grossman et al., 2013), providing additional support (e.g., Monte-Sano et al., 2014), and increasing explicitness (e.g., Silver & Stein, 1996).

As we analyzed the studies we reviewed, we were struck by the broad range of practices necessary to characterize the enactment of instruction that is designed to teach and promote sensemaking, as well as the multitude of purposes those practices served. However, we were also dissatisfied with how incomplete a picture these broad categories provided. Our conclusion was that, while these appeared to be “necessary” practices, they were insufficient to capturing the domain-specific nature of teacher practice in sensemaking contexts. For that reason, in the next section, we look closely at four studies, one for each of the disciplines we review, for the purpose of explicating the domain-specific nature of teacher practice. We selected studies in which the researchers provided significant detail regarding teachers’ practices.

### **Domain-Specific Teaching Practices**

#### *Science*

Recall that in the study by Manz (2016), the researcher was interested in how the teacher framed and supported the construction of evidence and how (third-grade) students’ roles shifted over time in this sensemaking activity. Consistent with the sensemaking literature, the construction of evidence was conceived of as a process of transformation. As we read Manz’s description of the instruction core to her research, we were reminded of the writing of Marcello Pera, a philosopher of science. Pera (1994) characterized *traditional* science in terms of a *methodological model* in which scientific research is a game with two players—the scientist whose inquiry raises questions and nature that provides the answers. The impartial arbiter in this game is method, ascertaining whether the game was conducted well and determining when it is over. Pera (1994) noted, “As it is guided or forced by the rules of the arbiter, nature speaks out. And ‘knowing’ amounts to the scientist’s recording of nature’s true voice, or mirroring its real structure” (p. ix). In contrast, presenting a more contemporary view, consistent with a sensemaking perspective, Pera presented a *dialectical model*, in which there are three players: an individual or group of individuals, nature, and another group of individuals that debates with the first according to the features of scientific dialectics. From this perspective, there is no impartial arbiter, nature responds to a “cross-examination,” and knowing emerges from the *community’s agreement* upon nature’s correct answer. Furthermore, as Pera noted, agreement among the members of a community is not merely conversational because it is constrained by nature. For the dialectical process described above to be at play in classrooms, there must be opportunities for students as community members to express disagreement and skepticism.

Manz (2016) documented this dialogic process, tracing how the participating teacher and students constructed and negotiated evidence. She labeled talk in terms of “epistemic levels” (such as noticing, claims, and facts) with each level representing a shift in sophistication and a move toward identifying generalizable facts. Manz (2016) documents how, when the instructional dialogue was initiated, the teacher assumed a primary role in the evidence construction process by making connections

among the epistemic levels, rendering the relationships among comparison, evidence, and claim transparent to the class, and purposefully “shifting the level of conversation from one level to another” (p. 1124). As instruction proceeded, there was evidence that the students assumed a greater role in the evidence construction and the teacher’s role shifted to include revoicing student contributions, prompting for connections among the epistemic levels, and problematizing particular ideas contributed by the students. Manz (2016) concludes that the most noteworthy aspect of the teacher’s practice was the manner in which the teacher made visible the relationships among the epistemic levels.

This study illustrates the value of investigating teacher practice over the course of time (in this case, over 18 lessons). Furthermore, the richness of the findings was enhanced by the contribution of the discipline-specific framework that represented evidence construction as transformation and provided a useful tool for characterizing shifts in the teachers’ practice over time, in response to what the students were increasingly able to do independently. Finally, this study reveals the role that the teacher’s content knowledge for teaching (Ball, Thames, & Phelps, 2008) played in the teacher’s practice.

### *Mathematics*

To illustrate the close study of teacher practice in the context of mathematics teaching, we selected the research reported by Mueller et al. (2014), who studied one teacher’s practices as she supported her (sixth-grade) students who were participating in an after-school program for 12 two-hour sessions. The teacher was a participant in an intervention titled the Informal Mathematics Learning Program, which supported teachers to constitute a community of mathematical learners co-constructing arguments, justifying solutions, and engaging in mathematical reasoning. Similar to the study by Manz (reviewed above), the researchers brought a clear theoretical stance to the design of the intervention. For example, they conceive of the teacher playing a minimal role during the initial exploration of a mathematical problem to “encourage students to engage in mathematical discourse, share representations, co-construct ideas and justifications, and ultimately take a more active role in their own learning” (p. 2). However, they also note the important role that teacher questioning plays in inducing learners to engage in elaborated forms of reasoning that are likely to lead to deeper understanding. As we suggested earlier in this review, these authors identified task design as playing a critical role in establishing sensemaking opportunities, as does listening carefully to students.

Using video data from which the researchers identified critical events, they transcribed and coded the data, which enabled them to construct a storyline and compose a narrative (described in Powell et al., 2003). The goal of this approach to analysis was to investigate the effects of the teacher’s moves on learners as evidenced by their ideas, arguments, and solutions.

Mueller et al. (2014) identified three categories of moves that were salient in accounting for student engagement in mathematical sensemaking. The first were those moves that served to make students' ideas public; these moves were especially prominent in the first two of the five sessions analyzed. The second and third categories of moves were those that elicited and extended students' ideas and encouraged explanations and justifications; these moves were in play particularly when the tasks were more challenging for the students. These moves encouraged persistence and provided an occasion for emphasizing the importance of collective problem solving. Interestingly, the researchers observed that students began to appropriate these moves in their own exchanges with one another. Furthermore, there was more evidence of these moves when the mathematical problem encouraged multiple solutions. One interesting pattern that the researchers characterize is the relationship between teacher moves, such as considering the reasonableness of a proposed solution and the opportunities for students to attain increased mathematical autonomy.

Similar to the study by Manz (2016), this study illustrates the value of investigating teacher practice across time; practices that were more or less ideal for supporting sensemaking looked different across the sequence of lessons. The rich, qualitative data that these researchers collected enabled them to make claims about the different purposes that various teacher practices served and the relationship between those moves and features of the task. In fact, one of the most interesting insights from this study was the important role that choosing and analyzing mathematical tasks plays in determining the usefulness of various teacher practices. This finding speaks to the role of content knowledge for teaching in mathematics as well.

### *History*

To explore practice specific to the teaching of history, we selected the study reported by Monte-Sano et al. (2014). Recall that these authors were committed to integrating the teaching of history with the teaching of reading and writing. They studied two expert eighth-grade history teachers implementing a curriculum that integrated the disciplinary use of evidence in writing historical arguments from multiple historical sources. The "disciplinary use of evidence" includes recognizing bias in sources, comparing evidence across sources, situating evidence in its context and taking into account different perspectives and multiple causes (p. 543). To support teachers in this activity of historical sensemaking, the researchers introduced two disciplinary-literacy tools: a mnemonic device, IREAD, which prompts students to read the whole document once, annotate to connect ideas in the text to the question(s) the reader is pursuing, and reflect on the source and context. The second tool, H2W (How to Write Your Essay), proposed a five-paragraph essay that contained an introduction, two supporting paragraphs, a rebuttal paragraph, and a conclusion (all of which were framed in historically specific ways).

It is not possible to do justice to all of the observations that Monte-Sano and her colleagues made regarding the teaching practices they observed as the two teachers

enacted this intervention; we present the highlights. Thinking aloud was prominent in their practice, particularly in the initial phase of instruction, followed by guided practice. When introducing the texts with which the students would work, the teachers framed these texts as arguments that would be used to support the students to construct their own arguments. There were important differences between the two teachers. For example, the teacher who had more struggling readers provided more explicit support, modeled longer, and more actively paced the students' work. Both teachers, who revealed strong content knowledge, encouraged more complex forms of reasoning with the texts, supporting the students to use context to interpret the authors' meanings. In addition, and particularly relevant to teaching for sensemaking, both teachers were attentive to building the relevant background knowledge that would facilitate making sense of historical controversies and primary sources so that the students could, in fact, evaluate those sources.

There are interesting parallels between the interventions studied by Manz, Mueller et al., and Monte-Sano et al. Making thinking public (regarding scientific, mathematical, and historical thinking) was integral to instruction in each of these studies. While, once again, studying practice over time made it possible for the researchers to document how the practice changed over time, studying the practice of two teachers who had students with different levels of literacy proficiency made it possible to see how the practices took these differences into account. Once again, the enabling role of teachers' content knowledge for teaching was salient in this research.

#### Literature

We conclude our investigation of disciplinary-specific practice by looking closely at the research of Aukerman (2013). What distinguishes Aukerman's research is the salience of sensemaking in her instructional orientation; she does, after all, label her approach *comprehension-as-sensemaking*. As described earlier, she distinguishes this approach to the teaching of literature from *comprehension-as-outcome*, with its focus on leading students to "correct" readings of text and *comprehension-as-procedure*, with its focus on engaging students in particular ways/routines/strategies while reading. What distinguishes *comprehension-as-sensemaking* is its acknowledgment that sensemaking is something that readers must do; the difference is that, when one brings this orientation to the teaching of comprehension, there is an openness to the understandings that students achieve through their intellectual work, even if that understanding and the ways of arriving at that understanding do not align with the teacher's.

What are the practices associated with teaching reading comprehension-as-sensemaking? Aukerman (2013) has enumerated these practices. They include (a) inviting students to read texts where divergent understandings are likely to become visible, ones that will challenge but not overwhelm the students who will be making sense of them; (b) putting students in situations where they exercise their own textual authority rather than consistently positioning the teacher as the only textual authority (e.g.,

by withholding evaluation of student responses, whether these lie within or outside perceived institutional bounds); (c) expecting that all classroom participants take the sensemaking of others, within and beyond the classroom, seriously (e.g., by asking students to consider closely the contributions of a low-status student; or by asking them to engage with a published critique of a text being studied); (d) facilitating frequent opportunities where students' sensemaking and resolved meanings become visible, develop, and intermingle (e.g., by facilitating dialogue rich with teacher uptake and open discussion among students, particularly when divergent understandings begin to become visible); (e) encouraging students' awareness of how others respond to the meanings they resolve, and also of how these responses might matter given the purposes that are at stake for them (e.g., by pointing out disagreements or places where a course of action chosen on the basis of one's sensemaking—such as following a written series of steps to conduct an experiment—might be rewarding or disappointing to the reader); (f) making additional social, cultural, and semiotic resources available for the reader to do her/his work, and encouraging students to make creative use of such resources (e.g., by supporting students' decoding proficiency or vocabulary knowledge; or by pointing out how her/his own cultural blinders might have made her/him initially unaware of certain textual possibilities); and (g) inviting students to consider potential new purposes and interests as they engage with text (e.g., by inviting students who are particularly drawn toward pictures in the text to consider how engagement with the words might open different doors for them as readers; or by suggesting that stories can be read with a feminist or critical lens, as well as for the content of the story). Aukerman is careful to add that students' understandings are not beyond critique; the expectation is that, sensemaking is transformed through dialogue.

The social nature of sensemaking is salient in each of the four studies that we reviewed; in each case, the teacher and students are encouraged to make their thinking "public." With the exception of Aukerman (2013), the teacher's use of public thinking provides learners access to expert sensemaking (scientifically, mathematically, historically) and provides students access to heuristics, resources, and tools that will advance productive sensemaking in disciplinary-specific ways. Construction, co-construction, and transformation are synonymous with sensemaking across these contexts. The context features phenomena, problems, and/or texts that serve as grist for sensemaking. Finally, both teachers and students play prominent roles in the instructional contexts, with teachers' moves responsive to student engagement.

In the next section, we look across the studies reviewed for the purpose of identifying implications for teacher learning/development and for research.

### **IMPLICATIONS FOR TEACHER LEARNING AND TEACHER DEVELOPMENT**

To answer the question "What are the implications for teacher learning/teacher development?" we constructed a table in which we arrayed the implications for

teacher learning and development identified by each of the 24 instructional studies that we analyzed. We then examined those implications for patterns in the categories that emerged. Four categories emerged from this analysis.

The most frequent category of implications for teacher learning and development was a category that we describe as *framing and enacting opportunities* for students to engage in sensemaking. Referring to sensemaking with text, Aukerman (2013) proposed that “reading comprehension pedagogy should shift from its current focus on institutional understandings to a primary emphasis on eliciting, illuminating, and juxtaposing students’ sensemaking” (p. 20). Doing so requires teachers to provide opportunities for students to engage in the work of sensemaking in the classroom. Across disciplines, the studies that we analyzed identified implications for practice related to the ways in which teachers provide and represent opportunities for students to make sense of the world. For example, these studies called for teachers to provide students with opportunities to (a) engage in disciplinary thinking (Monte-Sano, 2011); (b) inquire, reason, and argue about historical events and scientific phenomena (Manz, 2016; Monte-Sano, 2008); (c) see history as an interpretive discipline (Monte-Sano, 2008); (d) exercise interpretive authority in evaluating text and talk (Aukerman, 2007, 2013); (e) make connections between and draw upon prior knowledge, everyday experiences, cultural practices, and new learning (Lee, 2006; McNeill & Pimentel, 2009); and (f) elaborate on their knowledge and reasoning (Wolf et al., 2006).

The second category of implications for teacher learning and development is related to the opportunities that teachers frame and provide for students to engage in sensemaking through a focus on *teacher education* and *professional development*. Multiple studies that we reviewed proposed that instructional practices are teachable; hence, teachers can be supported to use instructional moves—including discourse moves—in ways that foster students’ sensemaking (Grossman et al., 2013; Manz, 2016). Thus, if research and observation protocols can identify instructional practices that support sensemaking, teacher education and professional development can be designed to focus on enhancing teachers’ instruction. While it is important to initiate this kind of training in teacher education programs (Cervetti et al., 2014), research also points to the importance of providing teachers with professional development opportunities that are supportive and sustained over time (De La Paz et al., 2017). Professional development for teachers focused on creating opportunities for and fostering students’ sensemaking might target creating knowledge-centered learning environments (Pumtembeker et al., 2007); examining exemplary interactions among teachers and students during sensemaking activity (Hogan et al., 1999); and providing classroom supports for teachers to engage students in sensemaking, such as the use of tasks that build on students’ prior knowledge and experiences (Silver & Stein, 1996).

The third category of implications for teacher learning and development was the importance of teachers’ knowledge, including both *disciplinary knowledge* and *knowledge of students*. Multiple studies emphasized the importance of teachers’ disciplinary

knowledge—including but not limited to knowledge of disciplinary content—in fostering students’ sensemaking. For instance, facilitating sensemaking discussions requires deep content knowledge on the part of the teacher and allows them to notice and respond to students’ ideas (e.g., Cervetti et al., 2014; Monte-Sano et al., 2014). In addition to content knowledge, the studies that we analyzed called attention to the importance of teachers’ knowledge of their discipline (e.g., Herrenkohl & Cornelius, 2013; Monte-Sano, 2008). Recall that, in the majority of the studies we reviewed, the students were engaged in sensemaking in the context of disciplinary tasks, such as developing scientific or written historical arguments and interpreting literature. To engage students in disciplinary work, teachers must understand and be able to support students to engage in the practices of their discipline to make sense of the world in disciplinary-specific ways. Extending these ideas, Monte-Sano et al. (2014) described the ways in which it is necessary for teachers to use both their knowledge of the discipline and knowledge of their students in order to press student thinking and respond to students’ ideas.

The fourth and final category of implications for teacher learning and development is the need for *high-quality curriculum materials* to support instruction. Connecting to a point that we made earlier in this chapter, teachers’ instructional practices are always in interplay with the curriculum materials to which they have access. In other words, for teachers to productively engage students in making sense of the world, they must have access to curriculum materials that are rich enough to support this complex work. For instance, Hogan et al. (1999) pointed to the importance of a curriculum that encourages students to engage in knowledge construction. Other studies that we reviewed emphasized the importance of providing teachers with tools and materials that foster disciplinary teaching and learning—such as primary source documents in history—that can be used to encourage students to engage in disciplinary thinking and reasoning (Monte-Sano et al., 2014). To this end, Reisman (2012) argued for providing teachers with curriculum materials and lessons that focus on using discipline-specific strategies to make sense of the world. To support teachers to engage in the work of fostering students’ sensemaking, they need access to high-quality curriculum materials that align with and facilitate this process.

### DIRECTIONS FOR FUTURE RESEARCH

The complexity of supporting students’ academic sensemaking translates to a rich, multipronged research agenda. Specific to instructional practices, given the prominence of discourse moves, there is much to be learned about the efficacy of particular discourse moves in particular contexts, within and across particular disciplines, and at particular grade levels. Lee (2006), for example, advocated for research on instructional practices in order to determine not only what is *possible* but what is *generative*.

The field needs research exploring *teacher learning and professional development* in relationship to supporting students’ sensemaking. For example, we might ask about

the use of particular experiences and strategies—such as the use of video or transcript analysis, or the use of software (such as SenseMaker; Herrenkohl & Cornelius, 2013)—to support teachers who vary in their experience and expertise engaging in sensemaking instruction. Specific to the study of teachers, we might ask how teachers' beliefs about how students learn, the assumptions they make about their students as sensemakers, and teachers' own epistemic commitments influence their teaching practices and with what consequences.

There is the need for research that expands and diversifies the research contexts in which sensemaking instruction is conducted. As described previously, the majority of the research that we reviewed was small-scale qualitative research, focusing on one or a small set of classroom teachers. The effectiveness of identified instructional approaches and practices emerging from the research to date needs to be investigated in more diverse educational contexts.

Given the role that assessment plays in driving instruction, and given the challenge of designing assessment instruments that place a premium on sensemaking, we propose that research on assessment of sensemaking to inform curriculum and instruction would be valuable. Finally, we imagine that the next review of the sensemaking literature will find technology playing a prominent role in curriculum and instruction designed to promote academic sensemaking.

## CONCLUSION

There is general agreement that, in order to develop, retain, and reward great teachers, there have to be effective ways of understanding and representing great teaching, but this is an area that is fraught with challenges (Baker et al., 2010; Darling-Hammond, Amrein-Beardsley, Haertel, & Rothstein, 2012). Our review of the sensemaking literature suggested that using the lens of sensemaking offers rich potential for investigating and characterizing great teaching. Sensemaking is easily apprehended as an idea and it is resonant with our everyday ways of being in the world. We found remarkable consistency and specificity in the major categories of teaching practices across four disciplinary areas, and those that were unique to the disciplines offered important insights into the language, tools, and ways of reasoning that are valued within disciplinary communities. From a sensemaking perspective, teachers are advantaged when they value the experiences and knowledge that students bring with them into academic contexts. Such a perspective positions teachers to be respectful of students' ideas and to approach curriculum and teaching mindful of students' assets, an increasingly valuable stance in our increasingly diverse schools.

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