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Building Mental Maps: Implications from Research on Reading in the STEM Disciplines

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Building Mental Maps: Implications from Research on Reading in the STEM Disciplines

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In our roles as director of our university's writing center (Rebecca) and instructional librarian (Heather), we often find ourselves traversing institutional and disciplinary boundaries. As we collaboratively offer workshops on writing effective literature reviews, as we jointly visit classrooms to talk about research and writing processes, and as we co-lead sessions to cross-train our writing center tutors and graduate teaching assistants, we hope that the joint physical presence of both "the writing person" and "the research person"—weaving together our instructional activities, affirming each other's advice—will prompt writers and instructors across our campus to recognize writing and research as intertwined, iterative, and perhaps even (on our best days) empowering processes. But where is reading in all this?

We begin this chapter by synthesizing discussions of transfer in the rhetoric and composition scholarship on reading. As will become clear, recent considerations of transfer—particularly the question of transfer beyond first-year composition (FYC)—are wrapped up with a host of other concerns about students' limited reading skills. Motivated by our own work with advanced undergrads in the STEM disciplines, we offer two re-readings of the challenges facing college-level readers. To begin, we draw on a tradition of read-aloud protocols conducted with expert readers in the STEM disciplines to argue for a revised understanding of the challenges facing so-called "novice" readers. Then, perhaps more radically, we draw on recent research by Deborah Brandt

to fundamentally reevaluate the relationship between reading and writing. We conclude by using a site of our own instruction—a multidisciplinary course filled with undergraduate STEM majors writing research grant proposals—to consider how these perspectives might better inform our own pedagogies of writing, researching, *and* reading.

Readers in First-Year Writing Classrooms: Questions of Transfer and Other Concerns

Connections between Reading and Writing

Composition and rhetoric scholars interested in transfer of reading skills have focused on two central questions: Do FYC students connect what they're being asked to do as readers with what they're being asked to do as writers? And do students connect what they're learning about reading in FYC to their reading in other classes?

To answer the first question, scholars have focused on the perceptions of students and instructors. The handful of systematic studies of the connections students make between instruction in reading and in writing indicate that there is a persistent mismatch between the two. For instance, grounded in their experiences teaching a reading class linked to a first-year writing class, Sweeney and McBride conclude that writing instructors' professed values when it comes to organization, thesis, detail, vocabulary, engagement, and length are often difficult to reconcile with the essays students are assigned to read—a mismatch that understandably frustrates students. Gogan's surveys similarly indicate that FYC students "did not see the connection between the rhetorical genre awareness [promoted in a reading assignment] and more effective writing" (n.p.) and Keller offers an ethnographic account of a first-year student who struggled because "he did not have a clear sense of how the readings led to or complemented the writings in the course" (*Chasing* 130).

Perhaps not surprisingly, research indicates that instructors experience a similar disconnect. Bunn reports that while every one of the FYC instructors he surveyed believes there is a relationship between reading and writing, many fewer reported

actually working to "explain or teach those connections to students" (501). Keller ("Framework"), too, argues that there is a lack of connection between instructors' pedagogies of writing (which include a significant focus on revision) and their reading practices (which almost never provide feedback on readings or opportunities to re-read). On those occasions when instructors do work to make those connections, they most often do so through the use of "model texts" (Carillo; Bunn; Keller, "Frameworks"). But if instructors *do* make such connections, Bunn argues, they can increase student motivation and success in both reading and writing (512).

Connections between First-Year Writing and Subsequent Coursework

If scholars are optimistic about the potential for increasing students' sense of connection between their reading and their writing assignments, they are much less confident that students will draw connections between reading strategies cultivated in a first-year writing course and subsequent coursework (Manarin; Carillo). Studies of how students repurpose reading strategies gained in FYC offer mixed reviews. Keller's (*Chasing*) ethnographic study of students reading at school and at home, in high school and later in college, is not encouraging. When asked about reading outside FYC, Diana reports that she got relatively good grades but was frustrated by the increasingly divergent expectations in different disciplines; she describes herself as "guessing a lot" (133), and Keller suggests that "she did not seem to have metacognitive awareness of how she adapted as a reader" (132). David describes reading textbooks to extract the right answer, with no emphasis on rhetorical reading. But Diana and David are both first-year students; other research suggests that students may recognize more connections as they get further into their disciplinary studies. When Gogan interviewed students a full year after they had finished a required composition class that emphasized rhetorical reading of genres, even students who had, in earlier surveys, dismissed that assignment as unimportant later "credit[ed] the genre awareness assignment with the development of some of their current reading practices across the disciplines" (n.p.).

Although relatively few studies have offered specific strategies for promoting transfer from FYC to subsequent coursework, Carillo elaborates a pedagogical strategy she calls "mindful reading." In this approach, a range of approaches to reading (rhetorical reading, close reading, critical reading, etc.) "become the composition course's subjects of inquiry . . . [and] instructors would focus with students . . . [on] how each type of reading works in specific ways" (120–21). Becoming meta-aware of their reading strategies, Carillo speculates, may help students "recognize at what moment in their reading process they need to relinquish a particular reading approach and introduce an alternative one and why" (123). However, the effects of mindful reading have not yet been systematically studied.

Other Concerns about FYC Readers

In addition to concerns about whether first-year students are able to make links between their reading and their writing and whether they will choose to repurpose reading strategies developed in FYC for future coursework, three persistent concerns surface about the reading abilities of readers in first-year writing classrooms.

First, FYC readers focus on facts and correct answers rather than on authors making claims within rhetorical contexts. The scholarship frequently notes a tendency in students to see right answers and "correct" readings (Bunn; Keller, *Chasing*, "Framework"; Smith; Sweeney and McBride). To some degree, this approach to reading might be understood as an alternative to "reading rhetorically"—a strategy often promoted in the FYC classroom (Carillo 34). Haas and Flower's Braddock-winning article defines *rhetorical reading* as "an active attempt at constructing a rhetorical context [including authors, readers, and motives] for the text as a way of making sense of it" (167–68). One of the major findings of Haas and Flower's comparison of the reading strategies of "experienced college readers" (four grad students) and "student readers" (six undergrads enrolled in a first-year composition class) was the degree to which readers used rhetorical (as opposed to content or function/feature) reading strategies to construct the meaning of a text. Whereas only one FYC student made a single statement that was construed by the researchers

as rhetorical reading (1 percent of strategies used), expert readers read rhetorically 13 percent of the time. Although Haas and Flower compared a limited number of readers, other research supports the conclusion that compared to experienced readers, FYC readers show a marked absence of rhetorical reading.

Second, FYC readers demonstrate a striking (over)reliance on personal connections. Manarin found that students most often related course readings not to "another course, context, or concept but . . . to personal experience" (287); "instead of a close reading exploring an author's rhetorical choices," students would "declare the essay's validity based on their own experience" (288)—even when that strategy was counterproductive for an assignment that required rhetorical reading. This pattern of behavior in FYC readers—what some might identify as a type of negative transfer—is also lamented by Sweeney and McBride:

> Even with an understanding of the historical events and political climate that prompted Swift to write his proposal and an understanding that Swift intended his proposal as satire, many students could not get past their text-to-self disconnect, creating a point at which their ability to engage with the text stagnated. (607)

Finally, research from the Citation Project suggests that beginning college students struggle to understand complex sources in their entirety. In their study of papers written for a sophomore-level required research course, Howard and colleagues found that while students regularly engaged in patchwriting, paraphrasing, and even copying, they found no instances of summary, which they define as putting the main ideas of a paragraph or more of text into "fresh language" and compressing it by more than 50 percent (181). Instead, students operate at the sentence level, in one representative case plucking from a text of 240 pages sentences from only two pages (186). The lack of summary and the patchwriting of individual sentences together raise not only the question of "whether the writers understood the source itself but also whether they even read it" (186). This research is often cited (Carillo; Keller, *Chasing*, "Framework") to illustrate the ways in which students struggle to comprehend complex texts

and are therefore "apt to cherrypick a few sentences that seem to bear on their topic rather than applying the meaning of the whole text" (Brent 46).

In sum, the portrait that emerges from studies of readers in first-year and early general education classrooms is rather dismal: students don't understand readings or try to read them rhetorically, they cherry-pick quotes, they connect texts to personal experiences rather than other texts. And yet our own work with students leads us to a more optimistic view. While the research we've just summarized strikes a chord, we wondered if delving further into the scholarship on reading might give us other frameworks for conceptualizing college-level reading and how to promote transfer of those reading abilities into contexts beyond FYC.

Insights (and Challenges) from Research on Expert STEM Readers

We wondered: what might we learn by looking at the practices of expert readers? Given our work with students in the STEM disciplines, we were drawn to a small group of often overlooked studies that illuminate the behaviors of expert readers in the STEM disciplines: Bazerman focuses on theoretical and experimental physicists; Charney examines both grad students and established professors in evolutionary biology; Paul and Charney examine twelve professors from physics, engineering, mathematics, ecology, and meteorology; Shanahan, Shanahan, and Misichia examine the reading strategies of mathematicians, chemists, and historians. Collectively, these studies cast valuable light on the nature of expert reading with implications not only for how we understand the "novice" behaviors of writers in FYC classrooms, but also for the broader question of whether reading is a "generalizable" skill.

What Makes Expert Readers Expert?

Across these varied studies, three interrelated behaviors emerge. First, expert readers in the STEM disciplines **read selectively.**

Because they must balance the need to stay on top of the most current findings with the need to actually work in the lab, expert STEM readers do not read journals cover to cover. Instead they use author names (to judge credibility in the field) and titles (scanning for key terms to establish relevance to their own work) to decide whether to read an article—turning to the abstract if the title and author names are indeterminate (Bazerman 241; see also Shanahan et al. 408–9).

Second, expert readers in STEM disciplines **read nonlinearly.** These scientists rarely read the article sequentially, but instead hop from section to section "seeking what they consider news" (Bazerman 243). This nonlinear reading matters because previewing an article and skimming for its most relevant bits "can undercut the rhetorical force of an article" (Charney 214), increasing a reader's ability to read for their own purposes.

The tendencies to read selectively and nonlinearly are closely related to the third identified behavior: expert readers in STEM disciplines **read with a mental map of their disciplinary field** in mind. Although the terminology these scholars use varies, all invoke a constructivist approach to reading, emphasizing that meaning does not reside simply in the text but is constructed by the individual while reading a text. Bazerman uses the term *schema* to describe "structured background knowledge" that "affect[s] both the process of comprehension and the meaning constructed from the text" (236). Importantly, these expert readers' mental maps tend to have the researchers themselves—their interests, their research projects, their commitments—at their center. Paul and Charney note that when reading the introductions to new, somewhat controversial articles, "readers' first consideration was whether they could relate the reading to their prior knowledge and to their own work" (427); in this way, the mental map is connected to expert readers' inclination to read selectively.

Having a mental map of the scholarly field on which the reader can position him- or herself *and* the reading proves crucial when grappling with difficult texts—and the absence of a fully developed map can make it difficult for readers to critically evaluate difficult texts. Charney's study of evolutionary biologists points out that when reading a particularly challenging article both expert readers (professors) and novice readers (grad students) had

to expend effort to understand unfamiliar material. However, the presence of what Bazerman would call a schema and what Charney calls "a stockpile of knowledge and attitudes against which they could weigh [the authors'] claims" (216) influenced the frequency and quality of expert readers' evaluative comments. Whereas grad students were likely to merely relate the text to their prior knowledge, experts were "significantly more often engaged . . . in assessing the validity and value of the text" (217). A mental map, or schema, thus seems crucial to the behaviors of expert readers in the STEM disciplines.

How Do Novices Become Experts? The Case of Eliza

At first glance, the behaviors attributed to writers in FYC and general education classrooms seem a far cry from the reading strategies attributed to expert readers in the STEM disciplines. How could such a gap be bridged? Are we to believe that these expert readers were *always* the outliers, that they *never* quite fit the patterns of novice behavior? Perhaps. But Gogan's research suggests that students' use of their previously learned reading strategies can change over time—a finding supported by Haas's longitudinal case study of Eliza, an undergraduate student in biology.

Eliza's early experiences replicate the problem described by Keller's (*Chasing*) first-year students: although her FYC class focused on how authors made and substantiated claims, Eliza saw no connections to her chemistry and biology readings. In those contexts, Eliza "viewed her role as a reader as one of extracting and retaining information"—a strategy that was rewarded by her performance on tests. Her focus on "understanding what the book says" continued during her sophomore year, as she approached a research paper required for her cell biology course by locating sources and stringing together extracted facts the night before it was due. Haas persuasively presents this reading and writing experience as evidence of a continued disjoint with her earlier FYC class: "The attention to authors which surfaced during her reading for her English class in her freshman year had disappeared. There was no evidence that she viewed any of the texts she read as the product of an individual author's motives or actions" (63).

But, Haas notes, this approach to reading began to change during Eliza's junior year. Beginning to work in a lab significantly altered Eliza's view of reading and writing; she began to distinguish reading journal articles from "just textbook reading" (64) and began to see those articles as "manifestations of scientific action and human choices" (65). During her senior year, Eliza demonstrated nonlinear reading strategies, spent more time on figures and tables, and grew more critical of methods and results sections. Although she had "extensive writing assignments based on reading," she didn't describe them as research papers. Instead she understood them as forms of communication embedded in the life of a lab—a review article and a research proposal (65).

By her senior year, Eliza's reading activities had grown nonlinear and increasingly critical—a change not only in her discrete reading strategies but also in her identifications and motivations for reading. The importance of this identification with a community of practice is underlined by Haas's speculation that while some of Eliza's transformation might be chalked up to "natural development" or to instructional support (she was being asked to read fewer textbooks and more journal articles), Eliza's increased domain knowledge and the mentoring she received in the lab also played crucial roles. Haas's narrative of Eliza's development from a student diligently searching for facts into an emergent biologist reading critically between the lines of current research suggests that we really do need to look not just for application of discrete skills, but also at how readers read in specific contexts.

When Is a Novice Not a Novice? Or, Is "Expert" Reading a Generalizable Skill?

The critical importance of context, of background knowledge and sense of identification, for readers comes to the fore in Haswell and colleagues' replication of—and variation on—Haas and Flower's study of rhetorical reading. Hypothesizing that a reader's ability to read rhetorically might be influenced by prior knowledge or "repertoires" ("bodies of cultural value, knowledge and convention" [Haswell et al. 13])—an assumption reminiscent of Bazerman's focus on schema and what Haas refers to as Eliza's increasingly scientific "discourse"—Haswell et al. replicated the

study twice. The first time they used the same psychology textbook excerpt used by Haas and Flower; the second time they used a passage from a local newspaper article on gender differences in schools, written by a college senior.

Using Haas and Flower's passage produced very similar results: graduate students once again demonstrated rhetorical reading strategies far more often than the undergraduates did (7.2 percent compared to 3.4 percent). But when asked to read the second passage, which Haswell and colleagues chose to tap into the cultural repertoire of the undergrads, *both* groups of readers used more rhetorical strategies: undergrads increased from 3.4 percent to 12.9 percent, grads from 7.2 percent to 16.5 percent. The differences between the two groups, while not eliminated, were reduced considerably. Thus, Haswell and colleagues conclude, "What appears to be a lack in reading strategy may have been a lack of prior knowledge needed to activate strategies that the undergraduates did have but therefore did not use" (12–13). Haswell et al.'s work suggests that the use of expert reading strategies is at least as contextual as it is developmental. The difference may be individuals' ability to position themselves—their knowledge and motives and identities—in relation to those readings. Expert, college-level reading isn't just about discrete reading strategies, but about the contextual knowledge that activates their use.

For researchers and teachers interested in transfer of learning, this is a crucial insight. The question of the relationship between discrete skills that can be applied and the contexts in which individuals make those "applications" has been taken up at length in the research on transfer conducted in cognitive psychology. Much of the early cognitive psychology transfer scholarship focused on what has been called the two problem transfer paradigm, in which researchers attempt to track the application of a skill from a source problem to the target problem. This tradition of research opened up debates about whether sufficiently abstract strategies would be widely transferable or whether all expertise is context bound (e.g., Anderson, Reder, and Simon; Bransford and Schwartz; Greeno). But another, more sociocultural line of studies (e.g., Beach; Lave; Lave and Wenger) suggested that the abstract/contextual dichotomy may be largely a function of

research methods and thus turned our attention to the cultural contexts in which learning occurs.

To the degree that rhetoric and composition scholars have proposed reading pedagogies to promote transfer, they have focused on metacognitive awareness as a widely transferable strategy that can help individuals negotiate shifts in contexts (e.g., Carillo's mindful reading). But we'd like to offer an alternate view: selective, critical reading often depends on having a personalized map of the field. What defines novice readers is not their age, institutional position, possession of an ability to read any text rhetorically, or even a metacognitive awareness of different reading strategies—but the fact that they don't yet have a highly elaborated map on which to position themselves and the text as they engage with a particular reading. One of the challenges facing college-age readers, then, is the chicken-and-egg problem of constructing such maps for long-established and sometimes jargon-laden fields. Students need a map to guide them as they select texts, identify relevant information while reading them nonlinearly, and make critical evaluations of the content. But how does one acquire such a map? In part through reading, but also through meaningful participation in a community of learners (Haas; Gogan; Lave and Wenger).

This, then, is our more modest claim: the challenge of college-level reading resides to a large degree in the need to have a mental map of the field, a map that arises from meaningful participation in a community of learners. We turn now to our somewhat more ambitious claim: perhaps we need to understand not only the resources needed by individual readers, but also the institutional contexts in which student readers operate. Maybe we're not seeing the germs of "expert" reading because we've misunderstood the context in which reading operates within schools.

Insights (and Challenges) from Recent Scholarship

Rethinking the Relationship between Reading and Writing

When addressing the relationship between the acts of reading and writing, most scholarship assumes their compatible, mutually reinforcing qualities. Carillo, for instance, describes reading

as "writing's counterpart in the construction of meaning" (7). Salvatori writes that reading and writing are related and that, in fact, improvement in writing "is the result, rather than the cause, of th[e] increased ability to engage in, and to be reflexive about, the reading of highly complex texts" (659). Smith similarly argues that "college students' ability to write is limited by their ability to read" and that students "can never outwrite their reading ability" (60). Even when unwilling to make such strong causal claims, the scholarship is rife with invocations of "reading like a writer" (Bunn 506) and "reading from a writer's position" (Keller, *Chasing* 143). The flip side of this valorization of skilled reading as a necessary foundation for strong writing is that students' reading abilities are taken for granted: when they become visible is when they have proved subpar and thus reading instruction is seen as remedial (Carillo 10; Keller, *Chasing* 18). The common thread is that reading and writing are assumed to be closely and perhaps inextricably linked abilities of the successful student.

Literacy scholar Deborah Brandt challenges those assumptions. Building on the "cultural dissociation" between reading and writing described by Furet and Ozouf, Brandt argues that we have entered into a new era of mass literacy in which "writing seems to be eclipsing reading as the literate experience of consequence" (3). Convinced particularly by her study of writing and reading in workplaces, she notes that whereas historically the value of reading has resided in its "goodness," the daily literate demands of workaday writers are redefining the reading–writing relationship: reading increasingly "occurs within acts of writing and often as an interaction between one writer and another" (13). Coming to terms with this shift in mass literacy challenges the commonsense assumption that reading is the springboard and necessary foundation for writing, "that our literacy can only develop through how we read, and that how we read will condition how we write" (159).

Furthermore, Brandt directs our attention to the ways in which schools long informed by the "confines of a reading-privileged, school-based literacy" (91) may be ill-suited for the agendas and interests of young people who identify primarily as writers rather than readers. Although in our own teaching we have often assumed that the shift to becoming producers rather

than consumers is a momentous one, Brandt argues that there are pockets of students who already identify as producers—and that school structures are often not congenial to their priorities and behaviors. She uses the phrase "writing over reading" to

> indicat[e] how writing is given priority over reading in the participants' often busy lives, as the two might compete for time, attention, and mental energy . . . [and] to capture how participants pursued their orientation to writing in instructional and other social contexts where they were being construed (along with everybody else) as readers. . . . These individuals more often had to "write over" the reading bias in their environments as a measure of individual initiative, sometimes violating expectations even to the point of reprimand. (96)

Brandt deliberately distinguishes "writing over reading" from "reading like a writer," describing "writing over reading" as "a set of strategies that requires deliberate separation from the rules of reading" (96). Brandt also argues that certain educational traditions have "privilege[d] the heritage of writing over the heritage of reading" (110); these traditions include spoken word, hip-hop, and other endeavors "in connection with work, apprenticeship, professions, art, commerce, and publication" (115). We believe that the reading behaviors of expert scientists, geared as they are to the workaday practice of science, may provide another model of "writing over reading."

Brandt, then, offers a framework for radically re-seeing reading scholarship and encourages us to consider whether "writing over reading" strategies might further complicate our understanding of what it means to read at the college level. If as instructors we want students to behave as producers of knowledge, then we might (as Brandt suggests) start to look for evidence of "writing over reading" behaviors—and foster them.

"Writing over Reading" as a Frame for Reconceptualizing College-Level Reading

To speak of "writing over reading" may seem to denigrate reading, particularly when reading has so long been excluded from the central concerns of rhetoric and composition. We propose,

though, that "writing over reading" may lead to some reading strategies that look like novice behaviors but may in fact be more similar to the behaviors of expert STEM readers than is initially apparent. In particular, looking for "writing over reading" behaviors casts in a different light the critiques of first-year readers as prone to cherry-picking quotes and dependent on personal connections.

What from a more traditional framework of the reading–writing connection seems like writing from sentences rather than sources, might—from the perspective of "writing over reading"—be not so very different from the behaviors of expert readers in the STEM disciplines. Such readers evaluate arguments "not with respect to the correctness of the *entire* argument, but to how the reader can assimilate *pieces* into ongoing work" (Bazerman 249, emphasis added). The difference between FYC readers and expert readers, then, may be one of degree, not kind. After all, in *their* summaries of the Citation Project research, Brent, Carillo, and Keller all chose to quote the same two or three sentences that we did: did we cherry-pick, or are there often a few passages that are the most relevant for writers who share similar mental maps of the discipline? Granted, we have also in this chapter included a great deal of summary, and that lack of engagement with larger units of text is indeed troublesome in FYC writers. However, the absence of summary may indicate not a lack of ability to read long or complex texts but the lack of a mental map that enables an individual to read *certain* long or complex texts. Without a schema (Bazerman), the discourse (Haas), or a repertoire (Haswell et al.), it's hard to get a critical fingerhold. Thus, what from a traditional reading-to-write perspective may seem like insufficiently careful reading may, from the "writing over reading" perspective, be the strategic behaviors of expert readers.

Similarly, a "writing over reading" perspective invites us to reconsider the inclination of FYC students to make personal rather than intertextual connections. If expert readers do indeed rely on mental maps—on which they strategically position their own interests and research agendas—then many of the connections expert readers make are already necessarily personal. To some degree, those "personal" connections (e.g., how does this

relate to my lab?) are what make the critical, selective, evaluative readings possible.

Furthermore, Haswell and colleague's research interrogates what gets counted as "personal" for undergraduate readers. In addition to using Haas and Flower's original coding categories, Haswell et al. coded for three additional reading strategies: *personal narrative* ("commentary that interprets text via life experiences of the reader" [11]); *judgmental* ("commentary agrees or disagrees with the content of the text, or otherwise places a value on it" [11]); and *noncommittal* ("deals with content without relating the passage to personal experiences or making value judgments" [11]). Haswell et al. found that when reading the original, more challenging passage, undergrads were most likely to make noncommittal statements, doing so 93 percent of the time. However, undergrads made *fewer* personal narrative connections than the more experienced grad students (2 percent to 7 percent). The undergraduates' personal narrative comments increased only with the more familiar, second reading, jumping to 16 percent (while the judgmental statements held steady around 5 percent). What explains the small number of personal narrative connections—and the increase in the second passage?

The explanation, we believe, is the definition of what counts as personal: in the case of Haswell et al.'s study, personal connections are "interpretations of the text through the reader's life experiences" as a way of "instantiating prior knowledge schemata that are activated by information in the text" (11). To interpret a text through the writer's life experiences may be surprisingly like the behaviors of the expert STEM readers, who consistently made connections between the text and their personal knowledge of their field and their own research agendas. Might the "personal" readings that exasperate Manarin, Sweeney and McBride, and others—readings that turn away from intertextual connections and rhetorical readings—in some cases be more like the noncommittal readings that Haswell et al. establish are plentiful? If so, the problem is not personal connections but connections that *lack* a sense of a personal connection to the emerging mental map.

Taken together, the "writing over reading" perspective suggests that it may not simply be a question of whether students

think it is valuable to read rhetorically, but whether they have the resources to read rhetorically. It's not a question of getting students beyond the personal, but of getting them invested and located within a conversation so that their personal connections—like the personal connections of expert readers—become a meaningful leverage for critical analysis. While we don't deny that there are many areas for improvement in the reading strategies of college writers, we do find that Brandt's challenge to recognize the ways in which certain valorized types of reading do not always line up with the reading practices of many other active producers of text helps us to better understand the nature of active, critical reading in the STEM disciplines.

Developing a Pedagogy of Reading in the STEM Disciplines

In our capacities as research librarian and writing center director, we worked extensively with an undergraduate research seminar in the Honors Program of the College of Arts and Sciences. This seminar was designed by a psychology professor as an interdisciplinary introduction to research methods. In spring 2015, the course enrolled primarily STEM majors in their sophomore or junior year. The course is an elective, and the major assignment of the semester was to write a research proposal that would be submitted for review and possible funding by a special Honors Program grant. The psychology instructor designed the course with the expectation that, in addition to our repeated presence in the course curriculum, students would secure a faculty mentor in their discipline.

Our main focus in this course was to exemplify how information research and writing are integrated iterative processes that are fundamental to the overall research process in every discipline. Throughout our various meetings with students—in the classroom and individually—we both focused on the idea of entering into a research community. We worked with the students to develop and practice their skills in strategically searching and evaluating scholarly publications, taking notes as they read these articles, considering the "conversation" that occurs between scholars in

the form of publications, and incorporating the work of published scholars into their own research proposals. However, this sense of scholarly conversation and community largely focused on intertextual connections. We realize now that we had not thought very much about how students come to build their own disciplinary maps of their fields.

As we reexamine our work through the framework we've articulated in this chapter, we're particularly pleased with two components. First, the emphasis on note taking is even more important than we'd initially realized. The majority of these students described their note-taking strategies as practices they had developed haphazardly. Many of them had trouble articulating any system of taking notes while they read, and most students felt they were able to remember the important elements of any text they read; so far they had been successful in relying on their memory and highlighted quotes to develop their research papers. Composing this research proposal was the first significant challenge to their (previously) successful habits. During our in-class workshop, we worked to model note taking and to encourage the nonlinear, rhetorical reading strategies of expert researchers. While some writers remained skeptical, for others the articulation of intentional, rhetorical reading and note-taking strategies immediately resonated—and several other students changed their perspective on note taking later in the semester.

Second, multiple times during the semester, Heather reviewed students' selection and representation of sources through multiple versions of annotated bibliography assignments. Heather's analysis of student citations offers a kind of feedback that we gather is relatively rare. Keller (*Chasing*) notes that reading can "leave a trace in the use of sources" but also asks "how much time do teachers have to respond deeply to the reading involved in source use, rather than primarily to writing aspects such as the integration of quotations?" (37). As an embedded librarian in a course, Heather focuses on students' use of sources in exactly this way. When an annotation or citation looks problematic or the overall cohesion of the bibliography seems unclear, she finds and reviews the source(s) in order to write responses that may head off students' misinterpretation of individual texts and intertextual connections as early as possible. One of the great

advantages of the interdisciplinary collaboration in this STEM course—between course instructor, faculty mentors, writing center tutors, and research librarians—is the ability to offer more comprehensive support of students' reading, writing, and subject knowledge development.

In this way, then, what we've already been doing is compatible with our understandings of college-level reading. But looking back at our work through this framework also helps us to understand student struggles in new ways. Specifically, we can now see that although their work with a mentor means that these STEM students are often starting to move into participation in a community of learners, they most often have extremely rudimentary mental maps of their field. Often they are still in the early stages of trying to understand the phenomenon being studied and the techniques used in the labs: comparing the work of their labs to the methods of researchers elsewhere has not yet surfaced as a concern. Second, these honors students are students who—by and large—have thrived in the reading-to-write structures of their previous educations. To make the shift to read like an expert STEM researcher, to read selectively and nonlinearly in ways that are guided by a mental map, is a huge shift, not simply in terms of building a mental map but also in terms of experiencing a "critical incident" (Yancey, Robertson, and Taczak)—an experience that might nudge these students to explore and embrace new reading strategies.

Future Directions

As we look forward, we see several implications of this framework for our future teaching—implications that may help readers imagine their own pedagogies of reading. First, we would do more with mapping and the visualization of research communities. We would have students draw idea maps, to help visualize which scholars are clustered around which issues and methods. We might have them make timelines, to see the historical development of findings and of research methods. We might even have them writing dialogues—choosing several researchers on a map and scripting out where they'd be in agreement and where they

would disagree. Additionally, we would ask students to connect these researchers and their findings with the forums where the work was shared. All of this could help students recognize that making connections and creating a knowledge gap isn't just a textual strategy for an effective literature review: developing a mental map of the discipline is crucial for understanding one's own work in relation to others' work.

Additionally, Heather would aim to extend the discussion of students' selected sources and annotated bibliographies. This feedback seems to be a critical missing component in a majority of courses where instruction needs around subject matter and/or writing techniques overwhelm the limited class time. Perhaps students could be required to discuss the annotated bibliography with their faculty mentor in order to review the cohesion of their selected sources and to hear the mentor talk through their process of testing the content against their own map of the field.

Finally, we'd like to capitalize on the budding relationships with disciplinary mentors. One possibility is getting mentors more involved in modeling the reading process, perhaps sitting with a student and reading aloud. Such a real-time read-aloud protocol might give students insight into how their mentors choose and actually read articles: What criteria do they use to select articles to read? Do they read nonlinearly? How much do these mentors think of the work of their own labs as they read? While we imagine it would be difficult to get every mentor to do this on a regular basis, even building a video archive of several read-alouds could be a powerful tool in our emerging pedagogy of reading. Another way in which we might build on the expertise of mentors is by asking them to review, perhaps with the student, a small portfolio of documents generated by the student, including an early map of the field, the annotated bibliography, and any later maps or drafts of lit reviews. Such a conversation might not only provide the student direct feedback on their project but also provide us insight into how students' maps of their fields are developing.

Beyond our own future plans, we see great potential for future research in these areas. For instance, as a field we would benefit from more systematic examination of the ways in which students' disciplinary maps or schema impact their reading habits and success. Although we have a great deal of research on students'

entrance into disciplinary communities in relation to their *writing*, there is very little on how students develop their disciplinary schema through their *reading* practices. Furthermore, we've drawn in this chapter primarily on research conducted on STEM researchers/readers. Future research could turn to other disciplines and professions—building, perhaps, on existing research (like Wineburg's studies of novice and expert readers in history) and explore other, less studied areas as well. Finally, Brandt's argument that we have entered a new era of mass literacy in which writing is the primary mode of literate engagement—an era in which the traditional structures of reading and writing in schools may prove ill-suited to the activity of writing over reading—offers a profound challenge to both researchers and teachers.

Works Cited

Anderson, John R., Lynne M. Reder, and Herbert A. Simon. "Situated Learning and Education." *Educational Researcher* 25.4 (1996): 5–11. Print.

Bazerman, Charles. *Shaping Written Knowledge: The Activity of the Experimental Article in Science*. Madison: U of Wisconsin P, 1985. Print.

Beach, King. "Consequential Transitions: A Sociocultural Expedition Beyond Transfer in Education." *Review of Research in Education* 24.1 (1999): 101–40. Print.

Brandt, Deborah. *The Rise of Writing: Redefining Mass Literacy*. Cambridge: Cambridge UP, 2014. Print.

Bransford, John D., and Daniel L. Schwartz. "Rethinking Transfer: A Simple Proposal with Multiple Implications." *Review of Research in Education* 24.1 (1999): 61–100.

Brent, Doug. "The Research Paper and Why We Should Still Care." *Writing Program Administration* 37 (2013): 33–53. Print.

Bunn, Michael. "Motivation and Connection: Teaching Reading (and Writing) in the Composition Classroom." *College Composition and Communication* 64.3 (2013): 496–516. Print.

Carillo, Ellen C. *Securing a Place for Reading in Composition: The Importance of Teaching for Transfer*. Logan: Utah State UP, 2015. Print.

Charney, Davida. "A Study in Rhetorical Reading: How Evolutionists Read 'The Spandrels of San Marco.'" *Understanding Scientific Prose*. Ed. Jack Selzer. Madison: U of Wisconsin P, 1993. Print.

Gogan, Brian. "Reading at the Threshold." *Across the Disciplines* 10.4 (2013). Web. 14 September 2015.

Greeno, James G. "On Claims that Answer the Wrong Questions." *Educational Researcher* 26.1 (1997): 5–17. Print.

Haas, Christina. "Learning to Read Biology: One Student's Rhetorical Development in College." *Written Communication* 11.1 (1994): 43–84. Print.

Haas, Christina, and Linda Flower. "Rhetorical Reading Strategies and the Construction of Meaning." *College Composition and Communication* 39.2 (1988): 167–83. Print.

Haswell, Richard H., Terri L. Briggs, Jennifer A. Fay, Norman K. Gillen, Rob Harrill, Drew M. Shapala, and Sylvia S. Trevino. "Context and Rhetorical Reading Strategies: Haas and Flower (1988) Revisited." *Written Communication* 16.1 (1999): 3–27. Print.

Howard, Rebecca Moore, Tricia Serviss, and Tanya K. Rodrigue. "Writing from Sources, Writing from Sentences." *Writing & Pedagogy* 2.2 (2010): 177–92. Print.

Keller, Daniel. *Chasing Literacy: Reading and Writing in an Age of Acceleration*. Logan: Utah State UP, 2014. Print.

———. "A Framework for Rereading in First-Year Composition" *Teaching English in the Two Year College* 41.1 (2013): 44–55. Print.

Lave, Jean. *Cognition in Practice: Mind, Mathematics and Culture in Everyday Life*. Cambridge: Cambridge UP, 1988. Print.

Lave, Jean, and Etienne Wenger. *Situated Learning: Legitimate Peripheral Participation*. Cambridge: Cambridge UP, 1991. Print.

Manarin, Karen. "Reading Value: Student Choice in Reading Strategies." *Pedagogy* 12.2 (2012): 281–97. Print.

Paul, Danette, and Davida Charney. "Introducing Chaos (Theory) into Science and Engineering: Effects of Rhetorical Strategies on Scientific Readers." *Written Communication* 12.4 (1995): 396–438.

Salvatori, Mariolina. "Reading and Writing a Text: Correlations between Reading and Writing Patterns." *College English* 45.7 (1983): 657–66. Print.

Shanahan, Cynthia, Timothy Shanahan, and Cynthia Misischia. "Analysis of Expert Readers in Three Disciplines: History, Mathematics, and Chemistry." *Journal of Literacy Research* 43.4 (2011): 393–429.

Smith, Cheryl Hogue. "Interrogating Texts: From Deferent to Efferent and Aesthetic Reading Practices." *Journal of Basic Writing* 31.1 (2012): 59–69. Print.

Sweeney, Meghan A., and Maureen McBride. "Difficulty Paper (Dis) Connections: Understanding the Threads Students Weave between their Reading and Writing." *College Composition and Communication*. 66.4 (2015): 591–614. Print.

Wineburg, Sam. *Historical Thinking and Other Unnatural Acts: Charting the Future of Teaching the Past*. Philadelphia: Temple UP, 2001. Print.

Yancey, Kathleen Blake, Liane Robertson, and Kara Taczak. *Writing Across Contexts: Transfer, Composition, and Sites of Writing*. Logan: Utah State UP, 2014. Print.