Reading across the great divide: English and math teachers apprentice one another as readers and disciplinary insiders

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A teacher educator uses an apprentice reading project to teach new teachers about the ways they read in the content areas.

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In an era when scholars from the sciences, social sciences, and humanities are coming together to examine multidisciplinary topics ranging from human aging and the development of cities to African American culture and cognitive science, one institution still does a remarkable job of isolating subject area learning: the U.S. secondary school, where subject area departments stand as "realms of knowledge" (Siskin, 1994). The four dominant realms—science, math, English, and social studies—are marked geographically, socially, academically, and administratively in the vast majority of schools. Often comprising a wing of the school, an academic department serves as the center for its teachers' informal conversation, professional identity, and decisions about spending, curriculum, and course assignments. In this context, teachers from different disciplines rarely meet or talk across departmental boundaries, and the opportunities for intellectual exchange are few and far between. Such schools fail to nurture learning among the teachers working there (Darling-Hammond & Sykes, 1999; Little, 1990).

As a consequence, teachers become experts at their own subject matter, but they often become less expert at the content taught in other departments. At best, science and math teachers confer about which math program meshes best with the science curriculum or English and history teachers try to synchronize teaching a novel in one class with its historical context in the other. Even these conversations, however, keep the humanities and sciences isolated from one another. In such a fragmented, specialized environment, teachers in various departments are unlikely to talk about their common role as teachers of reading. In a middle school, teachers begin to see themselves as subject area specialists, with reading relegated to English teachers or reading specialists. In a secondary school, even English teachers think of themselves as specialists in the teaching of literature and writing but rarely reading (Ericson, 2001). At the higher grade levels, teachers assume that because students can say the words on a page they understand them as well. Too often this is not the case (Greenleaf, Schoenbach, Cziko, & Mueller, 2001).

As a teacher educator responsible for a course on reading in the subject areas, I want all new middle and secondary school teachers, regardless of discipline, to view reading as their responsibility. I also want to break down the department walls between subject areas in middle and secondary schools that prevent teachers across the profession from talking about their common duty to ensure that all students read well. As a means toward those ends, I asked the preservice teachers in the course I teach to read

regularly in their discipline, to reflect in writing on their reading, and to read and respond to the writing of a colleague in another discipline. My intention was for new teachers to understand that reading is a process of making meaning from texts, to become more cognizant of their own strategies for reading, and to appreciate the different skills needed to read various genres in diverse disciplines. I also wanted new teachers to cross disciplinary divides to discover common intellectual concerns and to realize how they are both expert and novice readers depending on the type and subject matter of a text. I wanted these teachers to experience "reading apprenticeship"—a method in which the classroom teacher facilitates metacognitive conversations about reading including its personal, social, cognitive, and knowledge-building dimensions (Schoenbach, Greenleaf, Cziko, & Hurwitz, 1999).

"Reading apprenticeship" (Greenleaf et al., 2001) integrates reading with learning in the content areas of secondary schools. Based on the expertise that teachers and students in a community of readers bring to reading in their subject areas, it requires that teachers and students make explicit to themselves and one another the strategies and knowledge that they bring to reading texts in their discipline. Using the reading apprenticeship framework, teachers demystify and make visible the hidden mental activities that are part of comprehending a text. Many teachers, once aware of such strategies, would certainly be tempted to teach them in isolated lessons where students learn the strategies, practice them, and then are expected to incorporate them in their own reading. Because such expectations are no foregone conclusion, apprenticeship teachers develop their students' reading competence by building a classroom environment that brings together the multiple dimensions of reading—including the social, personal, cognitive, and knowledge-building dimensions—through metacognitive conversation (Schoenbach et al., 1999). Such conversations, making why and how one reads as much a part of subject area learning as what one reads, are described and analyzed in this article.

When teachers across the divide of English and math encounter one another over a text from one discipline or the other, what do they discuss? What are the notions of reading they hold, that they take for granted, or that they are surprised to learn are not universal when seen in the light of the other discipline? How can these conversations across the biggest disciplinary divide in secondary schools help both sides rethink what reading means? What are the implications for teachers in different disciplines as they come to see themselves as reading teachers? And what are the implications for teacher educators who want preservice teachers to implement a reading apprenticeship approach in their middle and secondary classrooms?

As the new math and English teachers described in this article read with one another across the disciplinary divide, they challenged notions that their academic disciplines are necessarily divided from each other, that they have little to say to one another, or that they address concerns exclusive only to one discipline. As a result, they came to see connections across disciplines and how English and math provide different perspectives on common themes. At the same time, they challenged simplistic notions that reading is a technical process with little differentiation across subject areas or types of text. As a consequence of these discussions, they developed a more complex view of reading, particularly its discipline- and genre-specific nature.

Reading in secondary schools

Middle and secondary school teachers find themselves charged with teaching subject matter but challenged by their students' difficulties with reading the texts that are central to so much content area instruction. As a result, many teachers call on their own "simple view of reading" as a basic, technical skill that is mastered forever and always by the end of elementary school (Gough, 1983). This assumption reinforces the notion that middle and secondary school teachers are not responsible for teaching reading, only for making sure students

understand subject area content. Many teachers avoid engaging students in texts and teach content by other means (Greenleaf et al., 2001).

Many middle and secondary school teachers resist teaching reading because they think it is "someone else's job," or they face contextual constraints that make reading instruction difficult (Alvermann & Moore, 1991; Konopak, Wilson, & Readance, 1994; Moje & Wade, 1997). As a consequence, schools are implementing reading programs, many of which rely on phonics and discrete, skills-based instruction to boost students' achievement, despite evidence that phonics instruction makes little difference beyond the first few grades (Braunger & Lewis, 1998; National Reading Panel, 2000). Most middle and secondary students who struggle to read can decode; what they need is explicit instruction in reading comprehension to understand the reasoning processes and strategies as well as the knowledge of the world, texts, and disciplinary discourses that good readers employ to understand texts (Allington, 2001; Delpit, 1995; Freedman, Flower, Hull, & Hayes, 1995; Hillocks, 1995; Pearson, 1996).

Against this background of content area teachers "working around" reading, researchers and theorists in English and math education have been pointing out connections between learning to read in these disciplines and learning these disciplines. In English, teachers and researchers have described practices such as literature circles (Daniels, 1994), question-answer-response (Raphael, 1986), storyboards (Wilhelm, Baker, & Dube, 2001), and independent reading along with conversation and interactive journal writing (Atwell, 1998) that are based on a transactional view of reading literature (Rosenblatt, 1978/1994). This view, which posits meaning arising through transactions between readers and texts in particular contexts, overlaps with approaches to teaching reading that develop students' metacognitive awareness and that encourage young people to connect text to themselves, other texts, and knowledge of the world. Paralleling this shift in reading and learning literature, knowledge in math as a certain and absolute entity has been challenged by conceptions of math knowledge as "a process of inquiry, ever open to doubt" (Borasi & Siegel, 2000, p. 15). In much the same way that the interpretation of literature is considered a transactional and social process, the construction of meaning in math is also the product of "discourse communities" where truth is established using language in a "rhetorical contest" to convince the "community of practice" that a claim to knowledge is warranted (Borasi & Siegel, 2000). In a math classroom where learning math is conceived not as the transmission of knowledge but as a type of inquiry or as participating in a community of practice, instruction focuses on the social process of "apprenticeship" into the discipline. Such classrooms engage students in thinking similar to the kind needed to become more thoughtful readers who generate questions and construct evolving knowledge from texts.

Description of the project and study

The preservice teachers whose work is analyzed in this study were in the fifth and final year of a teacher education program in the United States at Mills College in Oakland, California. Half were completing the requirements for a credential to teach secondary school English, the other half a credential in math. All were enrolled in Reading and Writing in the Content Areas, a course required for the California secondary school teaching credential, which I teach. One of the course assignments, from which all of the data for this study come, was a reading apprenticeship portfolio. The assignment was designed so new teachers could

- reflect on their own development and learning as readers,
- understand reading as an activity of making meaning and apply that understanding to teaching subject matter,
- practice strategies for making explicit the ability to read in different subject areas, and

Partner teachers and their reading

Teacher	Subject area	Book	Partner	Partner's subject	Partner's book
Denise	Math	Various mathematics journal articles	Marisa	English	*Of Mice and Men*
Jackie	English	*The Amazing Adventures of Kavalier and Clay*	Louise	Math	*Elementary Linear Algebra*
Joyce	English	*The Souls of Black Folks*	Robin	Math	*Flatland*
Meg	English	*Oedipus Rex*	Ruth	Math	*Fermat's Enigma*

- appreciate the disciplinary-specific nature of reading while crossing into new "reading territories."

Each preservice teacher in the class was partnered with a preservice teacher from another discipline. Whenever possible, I matched humanities teachers (English and social studies) with math and science teachers. I based this decision on past experience with preservice teachers writing to one another about their reading. When teachers in the same discipline wrote to one another, their comments tended to focus on *what* they read. When teachers wrote across the disciplinary divide separating the humanities from math and science, they were much more likely to reflect on *why* and *how* they were reading in addition to *what*. Often this additional attention to motivation and process was sparked by humanities teachers asking science or math teachers, "Why are you reading that?" or just as often, "How do you read that?" These questions frequently revealed the limited reading territories of humanities teachers. Teachers in all disciplines read novels, biographies, and even poetry. Among this small sample, only teachers in math and science routinely read nonfiction. Science and math teachers never questioned humanities teachers about why they read novels, which perhaps implies that new teachers define literacy as the ability to read literature, while humanities teachers felt no such reticence asking science and math teachers why or how they read texts rooted in those disciplines. Whether because they feared looking like philistines or because they had their own motivation and strategies for reading in the humanities, few science and math teachers asked their English colleagues to bring the same level of scrutiny to why and how they read.

Each teacher was asked to choose a text in his or her subject area that he or she had not read before but felt comfortable reading. In general, texts written for adults, rather than the adolescents they teach, worked best for this project. While math teachers chose textbooks in their discipline as well as trade books about math, English teachers read only trade books, from bestsellers to classics. The Table lists the teachers described in this article, the books they read, the teachers with whom they were partnered, and the partners' books (all names are pseudonyms).

I asked teachers in each pair to read different books because I wanted each teacher to have

the experience of apprenticing and being apprenticed in subject area reading. The teachers read their books over the course of a month and wrote a reflective log once a week, focusing not only on what they read but how and why as well. These logs were exchanged weekly with the partner who responded in writing with comments and questions. For the first three weeks, students read the text of their own choice. During the fourth and final week, they each read their partner's text, crossing the disciplinary divide with the help of the partner's log to make meaning from the new text outside their area of disciplinary expertise and comfort. I provided prompts for the logs to help the teachers record their mental activities and strategies for understanding texts. These included prompts to spark predicting, picturing, making connections, identifying problems, and employing "fix-up" strategies. After they completed their reading and writing, I asked them to have a metacognitive conversation with their partner to explore the following questions:

- What have you learned about reading in your own subject area?
- What have you learned about reading outside your subject area?
- How will you use this learning to help your students make meaning from the texts you assign in your class?

For this article, I examined the reading logs of four pairs of English and math teachers. (Because there are so few math teachers in the credential program, the number of pairs writing across this particular disciplinary divide is consequently small.) I coded the writing in the logs according to themes developed inductively based on a close reading of the texts. I asked students to check the accuracy of these categorizations. The themes fell into two categories: content and processes. The content category included themes, such as truth and equality, that the math and English teachers found common to their texts specifically and their disciplines more generally. The process category included the various strategies they used to make meaning from their texts. Even when the teachers felt a degree of comfort crossing the disciplinary divide, they were fascinated by how a reading strategy was employed differently in the two disciplines, for example "chunking" comprehension of a novel at the chapter level versus "chunking" comprehension of a math text at the sentence, phrase, or word level.

The nature of this study is exploratory. Its purpose is to help teacher educators think about how to engage all new teachers in discussions about one of their most important responsibilities: ensuring that all students read well. It is also designed to spur teacher educators' reflection about how best to spark the metacognitive conversations that allow teachers to explore reading's varied dimensions and to nudge teachers over disciplinary divides that isolate them and fragment students' learning. The following sections describe how new teachers apprenticing one another to reading in their subject areas made connections across the divide and developed more sophisticated understandings of reading as a discipline-specific process. The first two sections describe new teachers across the disciplinary divide making content connections through their reading. The third section illustrates new teachers' process connections focused on reading strategies and their differentiation by discipline and genre.

Searching for truth in math and literature

Meg, an English teacher reading Sophocles' *Oedipus Rex* (trans. 1949), and Ruth, a math teacher reading *Fermat's Enigma* (Singh, 1997), found themselves engaged in conversation about the nature of truth—a discussion that was informed by their personal interests, disciplinary perspectives, and the texts they were reading together. Ruth began this conversation when she explained her thoughts about Singh's description of the Pythagorean Brotherhood, a secret society whose members were dedicated to unlocking the mystery of numbers

and thereby bringing themselves closer to the gods. Ruth wrote, "This reminds me of some discussions I had as an undergraduate, where we likened mathematics to a religion of logic. In math, you can know that something is absolutely *true* and *right*." Meg responded,

> I am interested in our quest for certainty—and for those things that are "true and right." Can we be sure that math is "true and right"? Could it possibly still be simply our perspective or present understanding? This idea of course spills over into my own personal questions about religion, Christianity and spirituality—which is why it is interesting to me that you made the same link.

In reply, Ruth explained mathematical proof by quoting Singh.

> The idea of a classic mathematical proof is to begin with a series of axioms, statements that can be assumed to be true or that are self-evidently true. Then by arguing logically, step by step, it is possible to arrive at a conclusion. If the axioms are correct and the logic is flawless, then the conclusion will be undeniable. (pp. 20–21)

Meg found Ruth's thoughts illuminating and connected to her interest in "universal truths," something she was thinking of in terms of religion and faith as well as teaching literature. She wrote,

> I've been struggling with questions about if there are truly any universal truths. But this conversation, and your insight has reminded me that there are—mathematical—natural, universal truths. It has made me think a bit about how those ideas affect my understanding about different religions and my own spirituality.

At the same time, Meg acknowledged that

> something inside me rebels against the idea of absolute "truths." But mathematical absolute truths seem to take me into a totally different perspective. Math seems to be a field where theory and practice (or reality) have no separation. They are the same thing.

Meg brought this focus on truth to her reading of *Oedipus Rex*. In particular, she was interested in how the audience was privy to knowledge about truth that was invisible to characters in the play and in the intersection between sight and knowledge of truth. Reflecting on the role of truth in the play, she wrote, "It is interesting to note how many people knew the 'truth' [of Oedipus's incest] but looked the other way. Now only the thought of revealing the truth and its consequences makes them shudder—not the truth itself." When Oedipus's self-mutilation, the tearing out of his eyes, is revealed by a messenger in the play, Meg reflected,

> We hear [Oedipus's] words about blindness, but only through the messenger. How interesting and ironic that the audience is not allowed to see this act, extending the metaphor of sight and blindness. Do we truly know what happened if we do not see it? I'm interested in the idea that as Oedipus "sees" the truth, he loses his sight. But the assumption is that he "sees" all, and I wonder how clear his sight is even now that he is blind. Charagos says, "Your fate is clear, you are not blind to that." We don't know what his future fate is. We know he'll be cast out, but we don't know anything else.... We as an audience could "see" the truth for most of the drama but now that we've "heard" it, we do not "see" the future.

As Meg contemplated the connections between sight and knowledge, vision and truth, Ruth shared in Meg's intellectual excitement. She responded to Meg by saying, "I love your observation about the connection to sight. It's especially relevant since Oedipus's ultimate act of self-mutilation will be to gouge out his eyes. It's fascinating to me that Sophocles pulls this metaphor out in the beginning!"

This conversation challenged notions that only some realms of knowledge are responsible for conversations, like those about truth, that in fact cut across disciplinary boundaries. These teachers came to see themselves as connected by their intellectual interests. Reading and writing across the disciplinary divide illustrated for these teachers the power of reading beyond one's own

discipline and the potential for support in doing so with a colleague from another discipline. These new teachers learned to expand their "reading territory" into less familiar subjects and genres, and in the process they gained inspiration and insight, described later in this article, for helping students expand their own reading territories.

Exploring social justice in math and the humanities

Joyce, an English and social studies teacher reading W.E.B. DuBois's *The Souls of Black Folk* (1903/1993), and Robin, a math teacher reading *Flatland* (Abbott, 1884/1984), discovered common interests in connecting disciplinary reading to contemporary issues of social justice. They described their books as "not only about their subject matter, but [also having] relevant social and political implications."

Joyce connected DuBois's writing from the early 20th century to the racial climate at the beginning of the 21st. Thinking about DuBois's metaphor of waves to describe major strands of thought about racial equality after the U.S. Civil War, Joyce described social justice imagery in her mind:

> So as I read, I could see each thought as a wave, a human wave, rather than an ocean wave. He describes the first wave as being one of global cooperation, so I pictured black, brown, red, yellow, and white brothers working together. He describes the second wave as one made up of clowns, who see themselves as a third inferior race. So I pictured Bo Jangles who always accompanied Shirley Temple in all her dances, but never took center stage himself. And the last wave DuBois describes as composed of men who know not their own rights and ask for them timidly. So I pictured a man holding his hat in hand, with his head bowed, asking for what is rightfully his. DuBois's use of waves also makes me imagine the power of these waves to sweep people away, to stir up emotions, to churn up the environment.

In addition to calling upon her own knowledge to describe a scene as powerful as DuBois's, Joyce imagined her students when she read. In her journal, she cited DuBois's writing on responsibility. "So long as the best elements of a community do not feel duty bound to protect and train and care for the weaker members of the group, they leave them to be preyed upon by these swindlers and rascals" (1903/1993, p. 136). She described thinking about contemporary situations that might help her students interpret such writing.

Robin's reading of *Flatland* (Abbott, 1884/1984) paralleled Joyce's in its attention to imagery and connections to contemporary social issues. Abbott's 19th-century British novel, narrated by A. Square, describes Flatland, a two-dimensional world of geometry where the social classes of its inhabitants are represented by different shapes, with higher status signified by more sides to the shape. Women, who are lines, represent the lowest class. Robin was struck by the similarities in class structure between the characters and contemporary U.S. society. Focusing on the inequality of women, she wrote,

> There is a separate legislature for women that centers entirely around controlling them. Because they are lines, they are only visible from certain angles. If looking at one end or the other, they can be mistaken for points and can therefore sneak up on their male counterparts and pierce them (either injuring or killing them). Women are mandated in all states of Flatland to keep up a "Peace-Cry" so they can be heard at all times. In some states, they are required to sway from side to side (shake their backsides) so they can always be seen. They are considered stupid and forgetful and because of this are treated horribly by their husbands and other men in Flatland who assume they'll forget that anyone was rude or mistreated them.

Like Joyce, Robin connected her reading to the present day, reflecting on those people "thought of as secondary citizens and why." Connecting the Flatlanders' limited knowledge of worlds beyond two dimensions to current intolerance, she continued,

> I really think that those who are racist are frightened by the unknown and therefore try to confine or downgrade groups of people who they deem lesser. It made me think of the recent proposition which banned gay marriages that passed overwhelmingly in California. That to me was as offensive and ridiculous as the restrictions on women in this book. We really haven't come that far as a society and that is disturbing.

Joyce and Robin used reading in their disciplines as a springboard to conversations like those initiated by Moses (2001) and Oakes and Lipton (1998) connecting math and the humanities curriculum to issues of equality and social justice. Summarizing their experience of reading together, Joyce and Robin concluded, "it's critical to make connections to today's world in order to gain a deeper understanding and appreciation of the texts." When working with students, they said they would also "encourage students to make those links."

Drawing on the personal and social dimensions of reading, Joyce and Robin found areas of common interest—areas that grew out of their very different disciplinary passions. Without such conversations that roam across subject area boundaries, teachers have few opportunities to see where disciplines converge and how they can inform one another. Confounding their notions that "reading is reading" regardless of subject area, these teachers also challenged the stereotype that experts in their disciplines cannot talk to one another about content.

Metacognitive conversations

In addition to writing about content themes that these new teachers found common to their texts, they engaged in metacognitive conversations about how they were reading—their strategies for making meaning, their tools for identifying and fixing problems, and their motivation for sticking with texts that proved difficult or initially uninteresting. Writing to one another, they described strategies that included relying on one another for understanding, connecting to prior knowledge or other texts, predicting, skimming, rereading, annotating, picturing, looking ahead, skipping, questioning, and "talking back to the text" (i.e., carrying on a conversation with the author of the text). In this section, I describe these teachers' awareness of how the usefulness of various reading strategies depended on the discipline or genre of text. Such awareness contributed to their understanding of reading as a complex, discipline-specific activity rather than an uncomplicated skill that looks the same in all subject areas.

Jackie, a teacher whose background is in literature, and Louise, a high school math teacher, read *The Amazing Adventures of Kavalier and Clay* (Chabon, 2000), at the time a bestseller and Pulitzer Prize-winning novel, and *Elementary Linear Algebra* (Grossman, 1987), a college textbook. To read *Elementary Linear Algebra*, Jackie relied heavily on Louise for motivation and strategies. She wrote to her partner,

> I persevered even though I was lost. I had no language for what I was looking at, but I kept trying to make meaning out of the reading by referring to your log. Your log provided me with a template for learning math.... It was only because of the relationship with you and your log that I had a structure for beginning to read the textbook.

Jackie found inspiration to stick with a difficult text, following Louise who described the key to learning math as practicing problems again and again. Jackie found, "This comment gave me hope that I could learn math—that math isn't something learned magically; it takes practice and repetition whether you are skilled at math or a novice."

In the same way that Jackie challenged her assumptions about learning math, Marisa, a secondary English teacher, noted that she challenged her preconceived notions about learning math as a mechanical, rote process after reading with Denise, a secondary math teacher. Marisa wrote,

> A bias has existed between math and English people: Math is numbers only read one way (the right way) while English is open-ended. The implication is that

> math is something to memorize and English is something to ponder over. While reading Denise's journals, I was pleased to see that math people (as I suspected) do indeed ponder over, get lost over, and feel excitement over numbers on a page.

Jackie and Marisa gained more sophisticated ideas about reading in math by doing so with a disciplinary insider. Their insight, gained through conversations, underscores the importance of the social dimension of reading.

While disabusing one another of stereotypical notions of reading in their disciplines, the teachers did find real differences. Math teachers frequently reminded their English colleagues that reading a math text would not be like reading a novel. Ruth wrote to Meg,

> When I'm reading a math text, I like to have a pencil and paper in hand to work on problems as I go along, constructing meaning for myself out of the math on the page, even if an "answer" is presented along with the problem. Math builds on itself, so if you haven't understood previous material, you'll be lost.

Denise wrote to Marisa about how she slowed down her reading to comprehend articles from an academic math journal.

> I wrote in the margins several times that I had to reread sentences. I believe that in math there is a lot of rereading taking place because you have to understand what is being said so that you can understand the main point. You need one thing to understand the other. Also, I could see myself breaking up sentences so that I explained one word at a time. I would decode parts of the sentence and then put it all together so that I could make sense of the whole concept. At times there was so much information that I needed to understand that I could only look at a sentence in parts.

Louise and Jackie frequently compared strategies as Jackie learned that what served her well reading a novel did not help her with a math text. About *Elementary Linear Algebra*, Jackie wrote, "There was very little that had meaning for me, so when I came to the historical biographies, I read them carefully," because these were sections where she could draw on familiar comprehension strategies. Louise, the math teacher, noted, however, "I skipped them because they didn't have anything to do with math." Louise was defining her discipline as only about understanding mathematical concepts and their applications to problems. Jackie also tried a successful strategy from reading literature to gain clarity when she was confused. "I thought I could use the fix-it strategy of reading ahead but it really was not working." Louise responded, "There is no point in going on in a math text if you haven't learned the concepts being introduced." Given perseverance, Jackie did learn a strategy, however, for making sense of terms such as vector, scalar, and matrix that stumped her when reading the text for the first time. She wrote,

> If I look ahead I might find some story problems and that might help me better understand the concepts. I find several story problems. I look at the problem, and then I refer to the answer in the back of the book. The answer clarifies the concepts for me. Now I know what a row vector is, a column vector, and a scalar. The answer provides me with the concrete example I needed to understand the concepts. I try two more story problems and check my answers. I have now begun to understand the concepts.

In a similar manner, Meg and Ruth found disciplinary differences in how they read, particularly in whether they could read ahead with only partial understanding of what they already read. Referring to the Odes in *Oedipus Rex*, Meg, the English teacher, wrote, "The chorus parts seem long, disconnected, and tedious to read. I think I will read for the story first time through and then go back to read out loud through some of these philosophical poetic sections." Comparing this reading of literature to reading math, Ruth, the math teacher, replied,

> Unlike your ability to skip over the Odes and go back later...I think coming from my background I would be more likely to think that I would have to read through that intimidating Ode word by word until I

> understood it, which might turn me off from continuing with the play.

Ruth, like the other math teachers such as Louise and Denise, understood the importance of persevering and not skipping ahead when reading in math, but she also came to understand how that strategy is discipline and genre specific.

Many of the teachers commented on the importance of a "story" as a hook for reading difficult texts. Initially feeling lost in *Elementary Linear Algebra*, Jackie wrote, "I am interested in the story of math." She latched on to the biographies of mathematicians, drawing vivid pictures in her mind. On first picking up *Fermat's Enigma*, Meg wrote,

> The back of the book describes it as a "mesmerizing tale," and I'm excited to open it and start reading. But glancing through the book, I immediately find equations and math everywhere, and my next impulse is to shut it. This reminds me how wonderful it has been to hear the story through your [Ruth's] journal.... I'm realizing how necessary it is for me to be drawn into a discipline by a story or a narrative.

Even Ruth, the math teacher, commented, "I am more interested in the story behind the mathematics than just the math itself." When reading Meg's text, *Oedipus Rex*, she noted the importance of an engaging story and commented on her surprise that the text resembled a novel. Meg also appreciated reading *Oedipus Rex* as a narrative with a captivating plot, writing toward the end of the play, "I'm caught up in the story, even though I know what is coming.... So now I've read to the end, reading for plot even though there is no mystery of plot. How interesting."

By reading and writing with one another, the teachers gained increased awareness of the role that prior knowledge played in their understanding. Ruth drew on her deep knowledge of the history of math as she read. Mention of the famous mathematician Évariste Galois, for example, led to her following thoughts:

> What I was thinking when I read this was what I already know about Galois. He was a hotheaded young 19th-century rebel who flunked out of school and could not pass the entrance examinations for university. At the age of 21 he was challenged to a duel and died of a pistol wound in a field. The night before, knowing he was to die, he stayed up all night and committed everything he had in his head about mathematics to paper, feverishly writing all night. Most of the major theorems in Group Theory were written down by Galois in those last few hours before his death.

Meg, too, drew on prior knowledge. Of *Oedipus Rex*, she wrote, "I realize that I have never read this play although I know as 'we all do' what the story will be about." Later in her reading, she observed,

> Creon has been sent to Apollo's oracle at Delphi. I also "know" about this but not in any detail that I can remember. I wonder if we'll have to introduce Apollo and Delphi to our students for this information to register.

In response, Ruth connected Meg's questions to Hirsch's (1987) notion of "cultural literacy."

> You're right about the cultural literacy connection. I think so many "educated" people know about what *Oedipus* means, just from references to it (e.g., Freud and his complexes). I think I read the full play at some point, but mainly what I remember is the big concept of the man marrying his mother and her bearing his children. Oh, and that he plucks his eyes out at the end. I wonder, too, what a much younger person might know about the story.

Denise, writing to Marisa, found "that in math you constantly pull from prior knowledge. This prior knowledge is derived from definitions and concepts. If you do not know what one thing is, most of the time, you will be lost." In reading *Of Mice and Men* (Steinbeck, 1937/1993), Marisa did not draw on definitions but on a storehouse of disciplinary knowledge about how to read a novel, as demonstrated in her prediction after reading the first chapter of the book.

> I sense that whatever trouble that they [George and Lennie, the novel's main characters] had run from might be revealed later in the book, and the whole plot might even center on that. I think this relationship is a unique and caring one, but I think something "huge" is going to happen. I can picture them calm and free by the water, which I feel is a contrast to what surely waits at the end of the book.

As they reflected on their experience reading with others across the disciplinary divide, math and English teachers admitted that it had increased their knowledge, but they also recognized that knowledge, a key dimension of reading apprenticeship, contributed to their process of making meaning from texts. This realization raised for them a question about reading and knowledge development: How much "prior knowledge" should teachers provide students so they would read for meaning? Jackie, reflecting about her process of learning math, wrote, "I cannot be taught simply by reading the text. Math requires that a teacher demonstrate how the problem is done. The text is useful for reviewing the vocabulary and the formulas but not for learning the procedures."

While text should not be solely relied on to convey new information or develop students' understanding, these new teachers might have been concluding that text was always inappropriate or less efficient for building knowledge. This misunderstanding might have resulted from another misunderstanding—the persistent separation of learning from reading, the hard-to-dislodge view that reading is somehow passive or "less" than other forms of learning. These teachers' statements about needing background knowledge before reading cause me to reflect on the work teacher educators must do to prevent new teachers from creating a false dichotomy between reading and learning in a subject area. Such dichotomies contribute to the complaint many secondary content area teachers make: "I have too much content to cover so I don't have time to teach reading."

Preparing subject area teachers as teachers of reading

Conversations across disciplinary boundaries do not come "naturally" to preservice teachers. That is, such conversations need time and encouragement to develop. They also require teachers to challenge perceptions of themselves as "illiterate" outside their subject area specialties. Much of the value of these conversations, however, lies in their "unnatural" quality. In writing to a colleague who did not share the same knowledge about subject area or texts in the subject area, these teachers made explicit how their knowledge shaped their reading. They also discussed personal motivation for reading as well as the processes they used to make sense of texts that, to a person outside the discipline, might have seemed boring or impenetrable. In short, they apprenticed one another to reading in a foreign subject area. Louise demonstrated apprenticeship in reading by explaining how to read math with clarity and detail. She also displayed thoughtfulness and generosity to a novice math reader, Jackie, who she was apprenticing. Through Jackie's writing, Louise saw the power of stories to engage others in reading and learning math, and she learned new ways to think about supporting struggling readers in her math class. Jackie also explicitly shared background knowledge and her processes in reading, respecting Louise's less-than-novice status as a reader of fiction. In the process, Jackie, who saw herself as a reader of literature, analyzed how she read in order to teach others to read.

In another case, Meg read *Oedipus Rex* to prepare for teaching the play to her 10th graders. Meg's log illustrates the value of teachers reflecting on the reading they assign to students. Not only did Meg raise pedagogical issues about teaching *Oedipus Rex*, she also became aware of issues her students might face in reading the play and discovered strategies for helping them read a sophisticated text. For example, keeping a reflective log allowed Meg to ponder the importance of

plot and suspense in reading the play. By paying attention to how she read the play's Odes (first skipping them and then returning to read them several times), she became aware of a strategy that might aid her students' comprehension. As a result of her log, not only did she realize the value of rereading the Odes, but she could also explain to her students why such a strategy is helpful. Having seen the value of making explicit her own thinking, she is more likely to encourage such metacognitive awareness in her students.

Reading with colleagues from other disciplines has the potential to give teachers insight on the difficulty that novice readers, including their students, face when encountering texts that build on disciplinary ways of knowing and presume a certain level of knowledge in a subject area or about certain kinds of texts. While some teachers might bemoan their students' lack of subject area knowledge when they enter their classes, they are not likely to make the same complaint about other teachers. Reading across subject areas in the teacher education program leveled the reading playing field. Here were colleagues who respected one another's education and intelligence. Yet even these persons brought diverse personal experiences, values, and beliefs that challenged notions of what they assumed all literate readers shared. Their colleagues brought gaps in knowledge, incorrect information, and insecurities as readers that could not be chalked up to laziness, indifference, or resistance. As a result, these teachers had the opportunity to reconsider why some students do not read or why they do not understand what they attempt to read. They also had opportunities to reflect on how one teaches students under such circumstances to read in the disciplines.

Breaking down subject area divisions

Conversations across disciplinary boundaries about reading have the potential to mitigate the isolation and fragmentation of academic departments in most secondary schools. Through their logs, these teachers invited one another to become "initiated" in their disciplinary communities. They did so by explaining key ideas and knowledge in their fields and by providing one another with ideas for curriculum.

Most important perhaps to math and English teachers' initiation into another discipline were the connections they made and questions they asked their partners—connections and questions that went to the heart of their disciplines. Ruth and Meg asked each other about the nature of truth and proof. Robin and Joyce engaged in dialogue about equality and social justice. All these teachers wondered what role background knowledge plays in students' understanding of texts in their disciplines and how much background is needed. Reading with an experienced reader prompted the novice reader to gain a sense of wonder and provided an opportunity for what Duckworth (1987) called "the having of wonderful ideas."

Beyond the "essential questions" (Wiggins & McTighe, 1998) of their disciplines, they also shared with one another sophisticated, complex perspectives on their disciplines. As math teachers presented it, their discipline is not an exercise in "plugging and chugging" through equations where answers are right or wrong. Instead, it is a field of uncertainty and contention, vitality and relevance. English teachers portrayed a discipline where readers juxtapose their reading of classics with contemporary concerns, where readers—not only critics—give meaning to texts. Through their reading and writing, these preservice teachers shared their disciplinary loves. In the process, rather than looking only for common denominators of reading across genres and subject areas, they reveled in the particularities of reading in their fields. They helped one another gain an appreciation of reading's variability across disciplines—an understanding that serves as a first step toward building appropriate reading instruction into their subject area curriculum.

Implications of reading apprenticeship

Ball and Cohen characterized teacher professional development as "intellectually superficial, disconnected from deep issues of curriculum and learning, fragmented, and non-cumulative." Such "training" assumes teachers "need updating rather than opportunities for serious and sustained learning" (Ball & Cohen, 1999, pp. 3–4). It is unfortunate that preservice education and professional development in secondary reading often takes the "updating" approach, providing teachers with new standards, materials, and tests, but not opportunities to learn. These programs are generally designed to be "teacher proof," with the teacher serving as a technician who delivers instruction developed, or even scripted in the case of some reading programs, by others.

Describing a different course of professional education, Ball and Cohen called for changing teachers' "discourse of practice" from the "rhetoric of conclusions" to a "narrative of inquiry" (1999, pp. 16–17). While Ball and Cohen focused on teachers' inquiry into their students' learning, teachers' inquiry into their own learning (in this case learning about one's own reading processes) promotes a similar change in discourse. Many secondary content area teachers are unconscious of their own strategies as expert discipline-based readers and feel ill-prepared to help their students who struggle to make meaning from texts. These same teachers are the ones most likely to believe they can do nothing or to look for a quick fix to their students' difficulties with reading. They are the most likely to think that reading instruction means time away from exploring content or implementing decontextualized reading strategies to promote comprehension.

This project of apprentice reading across the disciplinary divide was designed to promote learning about one's own reading. It was also designed so teachers would learn about reading apprenticeship by engaging in it. As Meg noted in her final journal entry, "This assignment is exciting to me because it is one of the first ones... where I feel like we were actively making new meaning and connections ourselves." As the teachers in my class reflected jointly on their own processes as readers, not only did they gain self-knowledge, but they also gained practice in promoting colleagues' metacognition. Such practice is consistent with teacher education that honors teaching as a learning profession. It is also consistent with the conditions necessary for "the having of wonderful ideas."

As a teacher educator who values collegiality across disciplinary boundaries and who sees reading as one of the most important skills for a teacher in any discipline to develop among students, I hope that asking preservice teachers to read across the curriculum will allow them to pay more attention not only to *what* but also to *how* and *why* they read in their discipline. By reading and writing to others outside their discipline, they can learn how to translate and then share their process of understanding as expert readers in a discipline with colleagues who are novice readers in that discipline and who, in many respects, resemble their students. By working with colleagues, they will also practice apprenticing their expertise in ways that respect not only the experience and knowledge but also the dignity of novice readers.

REFERENCES

Abbott, E. (1984). *Flatland: A romance of many dimensions.* New York: Signet Classics. (Original work published 1884)

Allington, R. (2001). *What really matters for struggling readers: Designing research-based programs.* New York: Longman.

Alvermann D., & Moore, D. (1991). Secondary school reading. In M.L. Kamil, P.B. Mosenthal, P.D. Pearson, & R. Barr (Eds.), *Handbook of reading research* (Vol. 2, pp. 951–983). New York: Longman.

Atwell, N. (1998). *In the middle: Writing, reading, and learning with adolescents.* Portsmouth, NH: Boynton/Cook Heinemann.

Ball, D., & Cohen, D. (1999). Developing practice developing practitioners: Toward a practice-based theory of professional education. In L. Darling-Hammond & G. Sykes

(Eds.), *Teaching as the learning profession: Handbook of policy and practice.* San Francisco: Jossey-Bass.

Borasi, R., & Siegel, M. (2000). *Reading counts: Expanding the role of reading in mathematics classrooms.* New York: Teachers College Press.

Braunger, J., & Lewis, J. (1998). *Building a knowledge base in reading.* Portland, OR: Northwest Regional Educational Laboratory.

Chabon, M. (2000). *The amazing adventures of Kavalier and Clay.* New York: Picador USA.

Daniels, H. (1994). *Literature circles: Voice and choice in the student-centered classroom.* York, ME: Stenhouse.

Darling-Hammond, L., & Sykes, G. (Eds.). (1999). *Teaching as the learning profession: Handbook of policy and practice.* San Francisco: Jossey-Bass.

Delpit, L. (1995). *Other people's children: Cultural conflict in the classroom.* New York: New Press.

DuBois, W.E.B. (1993). *The souls of black folks.* New York: Alfred A. Knopf. (Original work published 1903)

Duckworth, E. (1987). *"The having of wonderful ideas" and other essays on teaching and learning.* New York: Teachers College Press.

Ericson, B. (Ed.). (2001). *Teaching reading in high school English classes.* Urbana, IL: National Council of Teachers of English.

Freedman, S., Flower, L., Hull, G., & Hayes, J. (1995). *Ten years of research: Achievements of the National Center for the Study of Writing and Literacy* (Technical Report No. 1-C). Berkeley, CA: National Center for the Study of Writing.

Gough, P. (1983). The beginning of decoding. *Reading and Writing: An Interdisciplinary Journal, 5,* 181–192.

Greenleaf, C., Schoenbach, R., Cziko, C., & Mueller, F. (2001). Apprenticing adolescent readers to academic literacy. *Harvard Educational Review, 71*(1), 79–127.

Grossman, S. (1987). *Elementary linear algebra* (3rd ed.). Belmont, CA: Wadsworth.

Hillocks, G. (1995). *Teaching writing as reflective practice.* New York: Teachers College Press.

Hirsch, E.D. (1987). *Cultural literacy.* New York: Vintage Books.

Konopak, B., Wilson, E., & Readance, J. (1994). Examining teachers' beliefs, decisions, and practices about content-area reading in secondary social studies. In C. Kinzer & D. Leu (Eds.), *Multidimensional aspects of literacy research, theory, and practice* (pp. 127–136). Chicago: National Reading Conference.

Little, J. (1990). The persistence of privacy: Autonomy and initiative in teachers' professional relations. *Teachers College Record, 91,* 509–536.

Moje, E., & Wade, S. (1997). What case discussions reveal about teacher thinking. *Teaching and Teacher Education, 12,* 691–712.

Moses, R. (2001). *Radical equations: Civil rights from Mississippi to the Algebra Project.* Boston: Beacon Press.

National Reading Panel. (2000). *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction.* Washington, DC: National Institute on Child Health and Human Development.

Oakes, J., & Lipton, M. (1998). *Teaching to change the world.* New York: McGraw Hill College Division.

Pearson, P. (1996). Reclaiming the center. In M. Graves, P. van den Broek, & B. Taylor (Eds.), *The first R: Every child's right to read* (pp. 259–274). New York: Teachers College Press.

Raphael, T. (1986). Teaching question-answer relationships, revisited. *The Reading Teacher, 39,* 516–522.

Rosenblatt, L. (1994). *The reader the text the poem: The transactional theory of the literary work.* Carbondale, IL: Southern Illinois University Press. (Original work published 1978)

Schoenbach, R., Greenleaf, C., Cziko, C., & Hurwitz, L. (1999). *Reading for understanding: A guide to improving reading in middle and high school classrooms.* San Francisco: Jossey-Bass.

Singh, S. (1997). *Fermat's enigma.* New York: Walker.

Siskin, L. (1994). *Realms of knowledge: Academic departments in secondary schools.* Bristol, PA: Falmer Press.

Sophocles. (1949). *The Oedipus cycle.* (D. Fitts & R. Fitzgerald, Trans.). New York: Harvest Books.

Steinbeck, J. (1993). *Of mice and men.* New York: Penguin Books. (Original work published 1937)

Wiggins, G., & McTighe. J. (1998). *Understanding by design.* Alexandria, VA: Association for Curriculum Development.

Wilhelm, J., Baker, T., & Dube, J. (2001). *Strategic reading: Guiding students to lifelong literacy.* Portsmouth, NH: Heinemann.