Narratives of "Dynamic Movement" in Disciplinary Literacy

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Abstract

Through a narrative inquiry involving a semi-structured interview and autobiographical reflection, the author explores the similarities and differences in literacy pedagogy between a literacy leader and a science teacher. Disciplinary literacy provides an opportunity for both teachers to better understand scientific literacy, and their different perspectives contribute to a rich conversation. Themes of similarities which emerge include embracing multiliteracies, investigation, a critical stance, and wonder Themes of differences include separating writing skills from form and confidence with numeracy and statistics. A collaborative approach to the implementation of disciplinary literacy and to further research is recommended.

The Landscape

Mandated standardized achievement tests have been implemented across North America with the goals of increasing the literacy achievement of adolescents. For example, Ontario has introduced the Ontario Secondary School Literacy Test (OSSLT) in grade ten and students must pass it or its equivalency through the Ontario Secondary School Literacy Course (OSSLC), in order to receive a high school diploma (Ministry of Education, 1999). Simultaneously, the influence of rapidly changing technology and an increase in accessible information has raised the literacy competencies required of adolescents (Meltzer, Cook Smith, & Clarke, 2001). In addition, changes in the nature of work will require students to utilize a range of sophisticated literacies in order to obtain and retain employment (Beaufort, 2009). These pressures have increased interest in the literacy education of adolescents.

Weeks (2002) explains, "how one defines literacy shapes one's whole universe in terms of what the goals and content of any given…program" (p. 9). According to the Ontario Ministry of education's *Think Literacy* resource document, "literacy refers to reading, writing, and oral communication skills in all subject areas for the purpose of developing and applying critical thinking skills" (2003, p. 1). In addition the Ontario curriculum grades 9 and 10 English states, "Literacy is a communal project and the teaching of literacy skills is embedded across the Ontario curriculum. However, it is the English curriculum that is dedicated to developing the knowledge and skills on which literacy is based" (2007, p. 3). Considering these definitions which focus on literacy as a generic set of skills developed in the English curriculum, it is not surprising that in Ontario schools the role of literacy leader often falls to English teachers.

Think Literacy "is intended for teachers of all subject areas from Grades 7 to 12" (2003, p. 1). However, research has pointed to content teachers' perception that literacy is a low priority (Fisher & Ivey, 2005). Content area teachers may "fail to see the usefulness of the strategies for meeting their instructional goals" (O'Brien, Stewart, & Moje, 1995, p. 446). Shanahan and Shanahan (2008) explain, "we have spent a century of education beholden to this generalist notion of literacy learning" (p. 2) which "has historically frustrated secondary content area teachers" (p. 1). Draper (2008) suggests that the current tension in content area literacy instruction is whether content area literacy should be a goal of instruction…or a tool to enhance or enable learning" (p. 2). On the goal side, McKenna and Robinson (1990) argue, "content literacy can be defined as the ability to use reading and writing for the acquisition of new content in a given discipline" (p. 184). On the tool side are generic content literacy lessons such as how to use a particular graphic organizer or tips on how to read a course textbook.

In 1995, O'Brien, Stewart, and Moje stated, "the future of content area literacy is caught between a rock and a hard place" (p. 447). An approach that has the potential to engage content teachers is disciplinary literacy which "is based on the premise that students can develop deep conceptual knowledge in a discipline only by using the habits of reading, writing, talking, and thinking which that discipline values and sees" (McConachie, et. al., 2006, p. 8). Proponents of disciplinary literacy, such as Shanahan and Shanahan, (2008) suggest that "as students move through school, reading and writing instruction should be increasingly disciplinary, reinforcing and supporting student performance with the kinds of texts and interpretive standards that are needed in various disciplines or subjects" (p. 12). For example, Juel, Hebard, Park Haubner, and Moran (2010) contend:

> Disciplinary habits of mind can extend student's reading comprehension by providing scaffolds for thinking. If a student knows that studying the natural world entails careful observation and thinking, then a student is more likely to observe and think about what she or he sees or to wonder about the causes of a particular phenomenon. If a student knows that scientific claims involve careful collection of evidence, he or she is more likely to ask for evidence from those who make scientific claims rather than accept them at face value…[Another] reason to support a disciplinary stance is because of technology. No longer do students jump to a set of printed encyclopedias; rather, they jump on the Internet. To understand how to evaluate all the information that is readily available online, students need to know the standard of evidence in a given arena. (pp. 14-5)

These compelling reasons have the potential to move literacy in the content areas beyond the literacy as a tool versus goal dichotomy.

Theoretically, disciplinary literacy is a solution to improving literacy and preparing student for an increasingly complex and technological world. However, high profile reports such as *Reading Next* (Biancarosa & Snow, 2004) and *Writing Next* (Graham & Perin, 2007), which advocate disciplinary literacy, "offer no indication of how content area teachers can combine their conceptions of content, pedagogy, and learning with workplace related reasoning" (Conley, 2008, p. 3). Draper (2008) also cautions that literacy educators outside of a subject discipline "may be unwittingly undermining the work of content area teachers. [Literacy educators] have the potential to do harm to content instruction by making recommendations that distract from or distort the content" (p. 15). Perhaps as a result of these concerns, research into the implementation of disciplinary literacy has taken on collaborative forms (Draper, 2008; Shanahan & Shanahan, 2008; Thibodeau, 2008).

I am a curriculum consultant with responsibilities in literacy, as well as a graduate student. Both my work experience and my research into literacy have led me to investigate the potential of disciplinary literacy to bridge the gap between content area teachers and school literacy leaders to benefit the adolescents we teach. The subject of science provides me with an opportunity to understand disciplinary literacy because it is not my area of expertise; however, I have many lived experiences with science on which I can reflect. Because "teachers are very seldom asked to testify and are seldom inclined to speak voluntarily for ourselves" (Robinson & Mackey, 2006, p. 170), I sought out the expertise of Ross (not his real name), a science teacher with industry experience, for his understanding of and perspective on scientific literacy. To elicit his insights, I conducted a semi-structured interview. I will compare and contrast our lived experiences with science in order to answer the following questions: What similarities in literacy pedagogy exist between a literacy leader and a science teacher? What differing beliefs about literacy do a literacy leader and a science teacher need to shift in order to collaboratively implement scientific literacy in a classroom? I have created a profile of myself and of Ross that summarizes our lived experiences with science and our views of scientific literacy. An analysis of the themes that emerged from the narratives follows the profiles.

The Negotiation

Profile of Self

I am a 40-year-old female who has taught high school English and drama for 11 years. I have also been a high school resource teacher and a literacy leader. Currently I am a curriculum consultant with responsibilities in literacy. I have always loved reading and helping others, which is why I became an English teacher. My interest in literacy research developed when I encountered an English class with students who struggled with literacy and I did not know how to help them. I have a Bachelor of Arts (Honours) degree and a Bachelor of Education. Currently I am worked on my Masters of Education degree. My family loves to read and I was always surrounded by books.

When I was 12 our family insulated our century home with urea formaldehyde, which was considered safe. Shortly after, my mother became deathly ill and was admitted to a hospital in Chicago, one of the first hospitals to recognize and treat environmental illness. The cost of her stay caused my family to lose our savings and our home. My mother recovered but her health has since been fragile. High school biology was one of my favourite courses. I considered going into biology but despite good marks, I did not feel I had enough math aptitude to obtain a Bachelor of Science. I took three half-credit biology courses in university as electives.

In February 2010, I was invited to attend a meeting involving science teachers and the implementation of the revised Ontario science curriculum (Ministry of Education, 2008). I had a 30-minute time frame to discuss how literacy and science were interconnected. Originally, my plan was to draw links between literacy and the curriculum and to model a think aloud. However, on the previous day I had met with our Board's school literacy leaders to analyze our OSSLT data on unsuccessful students. In groups, teachers analyzed the five reading selections from the 2009 OSSLT and the questions that posed the most difficulty, speculated on the reasons students chose the most common distracter, and brainstormed how we could respond to this information and analysis. The group with the graphic text, “How an eco-friendly fish farm operates,” (EQAO, 2009) concluded that they did not know what to suggest because they were not sure why the answer was right. Furthermore, they thought the problem was the question. As a teacher with an English and drama degree, I did not feel confident in my analysis of the text and the question. I told the literacy leaders I would discuss this question the next day with the science teachers in the hope that they could provide us with some feedback to help our students meet with success in this year’s upcoming OSSLT.

I needed the science teacher’s help; however, I was nervous because I was not sure how they would receive a discussion about literacy and the OSSLT at their meeting. To open, I drew links between the curriculum and literacy then I explained the confusion of the literacy leaders. To my surprise, a spirited and insightful 30-minute discussion about reading graphic texts in science took place. I learned more from that conversation than from the various reading for the content area books littering my shelves. I concluded the dialogue by showing the science teachers a reading/graphic text lesson plan developed by the Ministry of Education (2009) for grade 9 applied English, and asked them to share what they had just discussed with the literacy leaders at their school and with their students. The insights and enthusiasm of the teachers had me so motivated that I considered developing a live demonstration lesson that would involve my modeling for intermediate science teachers how to read a graphic text. With great excitement I shared this idea with the science leader who had invited me to the meeting. Kindly and gently, she explained to me that what I had in mind was not what science is about.

My response to my colleague’s critique was to further reflect on my experience of science. My personal understanding of scientific literacy is connected to my daily experience. I love gardening. I know that I have to buy drought tolerant perennials instead of annuals in my full sun garden if I intend to spend my summer holiday at the cottage. I compost because I know the food will break down and I can use it as fertilizer in my garden. I have read a number of books, looked things up on the Internet, listened to Ed Lawrence on CBC Radio One, and asked for advice from the garden company employees in order to establish and maintain my beds. I forget about the details of the water cycle but I know that if I spray my lawn, it may contaminate my well, which would result in consequences to my family’s health.

My life was dominated by scientific literacy during both my pregnancies. It is the only time in my life where I read science texts every single night. I subscribed to a website that sent me the weekly update of the fetus’ development. I read the relevant sections of several books that adorned my bedside table. I talked to my family and friends more often through the phone or by email. My husband bought a new camera and took lots of pictures to document the physical changes I was experiencing. My doctor advised me to use a midwife during my first pregnancy but I chose a gynecologist during my second due to some concerns. At the end of my second pregnancy I had an emergency ultrasound. The results were interpreted immediately and my daughter was born the next day to the chagrin of the admitting nurse who did not feel she had space to take me in at the hospital.

I am confident that I can learn things if I need to when it concerns the human body or the natural world. If I do not remember the terminology, I know I can locate information on the Internet. I do not understand the way objects work. I depend on my husband to fix everything around the house. If he is not available, I ask my ten-year-old son. When I have to sort out anything technical, my husband and son have asked me to stop asking them for help and to go read the manual, which I find to be a challenge. The demands of my current job as a consultant have required that I develop new literacy skills, which I count as scientific. For example this year I obtained, analyzed, interpreted and justified past OSSLT data to help my principals make some predictions to the Ministry about how our Board would do on the upcoming OSSLT. I also learned how to graph some OSSLT data this year, with support from my colleagues, to help classroom teachers target their instruction. At the same time I learned more about assessment validity and have taken a critical stance concerning the limitations of the OSSLT.

Although I enjoyed science in high school, I did not retain much of the textbook based material that I learned. I do remember working with a partner and discovering all the different forms of life in one square meter of a stream. We brought back some insects and analyzed them under the microscope in order to classify them, then graphed the results and compare them to the results of the rest of the class. I also recall a project where I had to take water samples at the north and south end of the Oshawa creek; by analyzing the south end of the creek I discovered the history of industrial contamination. I had to go to the local library to access the vertical files to obtain the information and I was able to get other information from my father who was involved in local politics.

My experience of science assessment was a lot of memory work for tests in biology and solving problems in chemistry and physics. There were labs in all the science courses, which comprised a part of our mark, and we could work with a partner. I only remember doing one oral presentation in biology where we had to present condensed information from a textbook and create a handout for our peers. In university, the science courses I took were electives that were large and lecture based. I took copious notes and we were assessed purely by pencil and paper tests. I remember taking away a sense of wonder from one course because the sheer number of examples we had of the unbelievable diversity of life.

Profile of Ross

Ross is a 39 year old male who has taught high school science, physics, math, and computers and technology for seven years in a geographically large rural school district. He also taught for three years in a large urban school district. In between the teaching positions, Ross was employed for three years in the manufacturing centre of a high technology company specializing in optics. There he worked as a test engineer developing testing processes, writing procedures, and analyzing test data of optical products. Ross holds a Master's degree in physics, a Bachelor of Education, and a Bachelor of Science. He chose teaching because he enjoys "helping others enjoy science." His older brother, who was involved with science, fostered Ross's childhood interest. Ross grew up on a farm. His parents surrounded their children with books, encyclopedias, and technology. Frequently, family discussions revolved around current events and sports gleaned from newspapers.

Ross's view of scientific literacy starts with a conceptual understanding of a body of scientific knowledge. He believes that comprehending specialized scientific vocabulary is linked with understanding the concepts. Ross acknowledges that students can find the vocabulary in a textbook challenging. As a result, he explicitly refers students to textbook features such as the glossary and goes over the vocabulary at the start of a unit. According to Ross "there is always new information you have to become adept with understanding and applying." As a result Ross was always reading in graduate school, in industry and continues to read to keep his scientific knowledge up-to-date as a teacher. He implicitly understands multiliteracies (New London Group, 1996): the types of scientific texts Ross refers to are graphs, charts, diagrams, textbooks, journal articles, numbers, satellite footage, YouTube, and software programs. Currently, Ross is using a set of eight-year-old classroom textbooks that he feels are outdated. For example, the international space station was just being built when the textbooks were printed. In his classroom Ross showed students a tour of the international space station, which he downloaded from YouTube. He uses a lot of visual materials and technology in his class since "students appreciate it and almost require it."

Ross's understanding of writing and oral communication in high school reflects the centrality of scientific conceptual knowledge of his pedagogy. The school writing tasks he refers to represent his understanding that writing is a means to illustrate to others what you know. For example, students write tests and lab reports to demonstrate their understanding of concepts and the results of "cookie cutter" experiments. The lab reports have to follow a consistent procedure and style. He refers to the need to illustrate what you know through visuals such as graphs and charts. He could not recall oral communication in his high school science experience other than listening to a teacher do most of the talking. He spoke about breaking down concepts to students as a part of how he understood oral communication in his classroom. In graduate school Ross completed an oral defense of his thesis in front of three university professors, which provoked some anxiety. He also presented posters at conferences which involved responding to questions involving his research.

The oral and scientific literacy skills involving writing and oral communication Ross experienced in industry required precision, clarity, and sequential steps. For example, Ross wrote product-testing procedures, which included visuals. These procedures had to be precise and clear because they were to be followed by several people, including several who were English language learners. Similarly, the oral communication he conducted in manufacturing consisted of "talking through a process" where his goal was for people to follow his exact instructions. Ross's experience in industry reflected written and oral communication employed as a tool to ensure the products shipped to customers met the industry standard through a quality control process.

For Ross, "scientific literacy also involves understanding how to apply scientific results and how discoveries can be applied into everyday life" and "how it is going to affect the world." The ability to do this comes from a perspective of "constantly inquiring and questioning." Ross feels that skepticism is also a part of scientific literacy. He is concerned that scientific discoveries get "hyped" too quickly in the newspaper, although he admits the newspaper is an important medium for communicating scientific discoveries to the general population. He believes "you want to find out about how the research was conducted" before you accept the results. That is why "writing up results and documenting the process" is central to science as knowledge claims are validated in science if someone else can reproduce the results of an experiment. He also believes numeracy is part of scientific literacy, particularly understanding statistics. When probed, Ross admits that ethics can be a concern in science, and drawbacks need to be weighed against the potential benefits.

Ross enjoys science and this is reflected in his pedagogy. His preferred approach to teaching science is to "give time to explore." However, he is concerned that "we have these cookie cutter instructions" during labs and "we take away that eureka feeling we have to cram through the curriculum." He recognizes that "boosting confidence" is necessary because science is difficult to read and does so by incorporating technology in his classroom. He acknowledges that students enjoy demonstrations and hands-on activities in science. He does not like to spend time asking students to memorize facts because "these days the kids can look it up so quickly on the Internet…I encourage them to do that if they have something that connects to the Internet if we are doing some research." Ross believes that "we need to get away from the facts and more into the concepts and how to interpret science."

Themes of Similarity

Multiliteracies

Both Ross and I view text broadly to include "increasing multiplicity and integration of significant modes of meaning making" (New London Group, 1996, p. 60). Ross regularly incorporates multimodal media in his classroom to enhance student's understanding of scientific concepts. Often he does this spontaneously in response to a student's question. Ross did not refer to all modes of meaning in the interview; however, his belief that the visual is a critical mode for scientific literacy and his experience teaching with technology leads me to infer that a discussion concerning linguistic, audio, spatial, and gestural modes (New London Group, 1996) of scientific literacy would be received with interest. I suspect Ross understands that "video clips may capture much of the visual appearance and sound of a natural phenomenon but lack tactile access, distort size and scale and have no smell or taste" (Olson & Mokhtari, 2010, p. 58) and this is why he brings in light bulbs and circuit boards for students to assemble when they study electricity. As Schoenbach and Greenleaf (2009) suggest, "even laboratory equipment and the phenomena explored in the lab require reading and interpretation" (p. 105).

According to LaMonde and Rogers (2007), "our youth live in an increasingly multimodal landscape, yet their schooling experiences are often limited to traditional language and literacy practices" (p. 19). Neither Ross nor I experienced designing multimodal products as science students and we both conceptualized science writing as reiterating scientific information, using relevant terminology, and employing appropriate genres, such as lab reports. We both need to consider that "students should be writing in digital environments in different modes" in science (Richardson, 2009, p. 30). For example, students could demonstrate that they understood scientific concepts by creating a website instead of by writing a paper and pencil test. LaMonde and Rogers "argue that sophisticated school literacy instruction includes a play of genre and media that engages even struggling students in the process of creating arts integrated and digital expressions of voice, critique, and social commentary" across the disciplines (pp. 2-3). Knoble and Wilber (2009) remind us, "2.0 literacies challenge how schools traditionally have valued a single author laboriously working alone to create a unique text" (p. 22). They recommend fifteen online resources that students could work on collaboratively that could be adapted for the science classroom. Given Ross's interest in and aptitude with technology, I believe he possesses "a perspective that broadens notions of language and literacy" (LaMonde & Rogers, 2007, p. 3) and would be willing to try some of these ideas out in his science class.

Investigation in context

A grasp of concepts "are the understandings that contribute to scientific literacy" (Ministry of Education, 2008, p. 6). Deepening one's understanding of scientific concepts occurs through various literacies. For example, when I needed to know what types of plants to select for my garden I did some reading. Many questions were exchanged between the garden centre staff and me before I settled on a purchase. Similarly, Ross uses an online software program to show students the constellations. He responds to their questions immediately by manipulating the images. In order to discover why my water sample from the south Oshawa creek showed more contamination than the north Oshawa creek, I had to go to the library and read articles on industrial pollution and ask my father a lot of questions. The American Association for the Advancement of Science (2002) believes "students should learn fundamental science concepts in the context of doing science" (as cited in Olson & Moktari, 2010, p. 58). Both my experience and Ross's illustrate that questioning should be considered an integral component of the investigation process. Ross understands that scientific knowledge is constantly changing and, as a result, he is constantly gathering new information to refine his knowledge. He promotes scientific literacy in context when he encourages students to look up information with their handheld devices when they have a question. Connecting investigations to life experience can make scientific concepts meaningful and interesting. For example, while watching Olympic mogul races a clip was aired about how the athletes' muscles and joints work to absorb the shock. This knowledge heightened my appreciation of the sport.

Critical stance

Both Ross and I understand that one has to be critical when interpreting science. Ross's understanding of the scientific method helps him to know "what counts as evidence" (Juel et al, 2010, p. 15) in his discipline is the ability to reproduce the results of an experiment. He is critical of the newspaper's reporting of scientific discoveries but knows that the public needs to be appraised of new information so they appreciate science. He considers peer-reviewed journals the most credible source of information, though he scrutinizes the method and looks for reproducible results. My life experience with urea formaldehyde insulation has taught my family the hard way that not having critical scientific literacy can have extreme consequences. Ross and I both understand that the benefits of science have to be weighed against the potential harm. Ross recognizes that semi conductors have the potential to move more pornography faster through the Internet; however, he feels that the benefits outweigh the risk. His example is that any tool, even a hammer, has the potential to do harm. For Ross, delving deeper into something, as one does in science, carries an intrinsic reward.

Wonder

The Ontario Curriculum grades 9 and 10 Science (Ministry of Education, 2008) intends for students to achieve "scientific literacy while maintaining a sense of wonder" (p. 4). The greatest moment of awe in my life occurred after the birth of each of my children. The reading, conversations, questions, ultrasounds, and photographs all contributed to my experience of the miracles that my husband and I created with our bodies. Ross is concerned that students do not get enough of that feeling of wonder. His understanding of wonder is reflected in his comment:

> Richard Feynman was talking about looking at a plant or looking at a rose. And some people would say as a scientist you don't see the beauty in this. You are always trying to rip it apart and study this. He was saying, how does that not help you to appreciate its beauty anymore? You are thinking about the biological process that is involved, the conversion of light into biological energy, sugars that it can use in its growth patterns. And so he thought that understanding science made something more beautiful when you look at it. Whereas artists and people on that scale would say, well, let's just paint it and not study it too deeply. Everybody has their own insights into things. As a scientist you can see a lot of beauty in things.

Themes of Difference

Form meets content

Ross believes that "in English [class] you get your writing skills down" and he linked English to creative writing. He felt the factual writing he did in science class prepared him for the writing he did in industry. My conception of writing is based on Beaufort's (2007) model, which includes writing process knowledge, subject matter knowledge, rhetorical knowledge, and genre knowledge, all of which are framed by discourse community knowledge. Ross's perception separates these components: writing is learned in English class and content and form are learned in science class. Students and teachers across the content areas would benefit from understanding how all of the components of Beaufort's model work together. Based on this common understanding, it is logical for a science teacher to have students draw on their content knowledge to write a newspaper article in science class, as Ross has done, when they understand how to use the writing process, the specific discourse, the form, and the conventions involved. It does not matter in which class students learn these components; the important part is that all the elements are made clear. It is reasonable for students to understand how to write a procedure in high school, as Ross performed in industry. Learning how to do so should be connected to content area knowledge: science is an appropriate discipline for this type of genre.

Similarly, there are recurring patterns in reading science which can be explicitly taught if done in context. Sejnost and Theise (2001) state,

> readers look for organization in everything they read… writers use various patterns of development to develop and organize their ideas. Because each pattern has its own logic, each one encourages the writer to think about a subject in a different way. (p. 49)

Olsen and Moktari (2010) suggest:

> Reading instructors should familiarize students with the hypothetico-deductive logic ("If…then") that permeates effective science instruction. Focusing on scenarios in reading that follow this logic structure – even when *if* and *then* are not explicitly used –helps students follow this complex logic so common to science texts. (p. 56)

My expertise with literacy research could assist Ross to determine the appropriate patterns to teach explicitly, provided that they are connected to understanding the scientific concepts being studied.

Numeracy and technology meet fear

Ross believes that understanding numeracy and statistics are a component of scientific literacy. In addition, Olsen and Moktari (2010) suggest, "helping students navigate [representations of data] not only promotes better understanding of the science content, but also provides important insight into science itself. Scientists function in environments that use symbol systems to represent natural phenomenon" (p. 61). Like many students, I am not confident with my ability to interpret and represent information symbolically and graphically. However, I do know the terms for analyzing graphic text forms such as print features, organizational/layout features, and design features (Ministry of Education, 2009), and it is important that students learn consistent terms in order to create, analyze, and interpret graphic texts. My expertise in this area could help Ross and his students to develop some new avenues to explore the interpretation of graphic information. From this perspective, literacy and numeracy are one in the same. My science colleague's statement that my live demonstration lesson was not what science was about guided me to recognize that my conception of literacy was generalist, and therefore problematic. It took her comments and an interview with Ross for me to realize that the heart of the discipline of science is investigation. Often the course of investigation requires multimodal reading and interpretation skills involving numbers, symbols, objects, and experiences. Collaborations between literacy experts and science teachers have the potential to fully explore the "metalanguage of multiliteracies based on the concept of 'design'" (New London Group, 1996, p. 73).

I have a lot to learn from Ross's attitude towards technology. I am in constant fear that my equipment will fail during a workshop despite the fact that someone is always around to help me if needed. Ross enjoys it when his students teach him something new. It is clear that accessing technology is "genuine textual [pleasure]" (Robinson & Mackey, 2006, p. 212) for Ross where it is a source of anxiety for me. The numeracy aspect of science was a welcome challenge for Ross and an impediment for me, and these responses became integral to both of our identities and career choices. Keeping in mind that "when identity is viewed as fixed, then those individuals who do not possess the expected set of characteristics are often marginalized" (Lewis & Del Valle, 2009, p. 310), teachers will need to be sensitive to the fact that the experiences students have with the numeric and technological component of scientific literacy can have effects that last a lifetime. Steps should be taken to mitigate any negative experiences and to build positive associations with numeracy and technology. A first step may be to assist students to understand identity and literacy as hybrid, metadiscursive, and spatial (Lewis & Van Del Valle, 2009).

The Bridge

Despite past concerns that content literacy is difficult to implement in high school (O'Brien, Stewart, & Moje (1995), this study points to evidence that science teachers are interested. Science teachers with pedagogy founded on principles of multiliteracies, investigation, a critical stance, and wonder share many common understandings of expanding notions of literacy with literacy educators.

McKee and Ogle (2005) explain "inquiry based science experiences provide the context in which students learn to think critically and develop understanding from concrete activities and print materials. The natural culmination of this kind of learning is that children learn to share their discoveries in written and oral form" (p. 12). Learning from multiple modes enhances students' understanding of science. If Ross is typical of a science teacher and I am typical of a literacy educator, the potential for rich conversation about scientific literacy is high. Such a conversation, however, needs to rest on the assumption that literacy instruction involves revealing to students how different disciplines present, interpret, share, and apply knowledge. As Schoenback and Greenleaf (2009) suggest,

> Literacy needs to be understood as a social, cultural, and cognitive activity shaped by particular communities and by the particular situations and contexts in which reading and writing [and other modes] occur. Academic disciplines, in this conception, are understood as socially constructed, evolving, and open to interaction with other disciplines. (p. 99)

As a literacy educator I "must take care to promote literacy in a way that includes content - knowledge about the physical, social, and aesthetic world – or [I] will find that [I] am promoting a literacy that is empty and vacuous" (Draper, 2008, p. 5). My ill-fated live demonstration lesson idea was too generic and failed to contextualize scientific reading. As a content area teacher, Ross needs to recognize activities in his classroom as examples of scientific literacy, and to share that recognition explicitly with his students. Both Ross and I need to move beyond the literacy as a tool versus literacy as a goal dichotomy in order to perceive "'literacy as a lens' for viewing content instruction and instructional problems within content area classrooms" (p. 15).

A readiness to embrace disciplinary literacy and a perspective of "literacy as a lens" does not mitigate the challenges of implementation. Ross is aware that a pedagogy of inquiry conflicts with the perceived need to cover the curriculum. There is also the question of the most effective order of instruction. As Olsen and Moktari (2010) point out, "the key to improvement lies in better instructional sequencing and better sense-making in class, rather than in inserting reading comprehension strategies that are devoid of context and focused on memorizing vocabulary" (p. 61). They recommend the learning cycle/guided inquiry (Macheno & Lawson, 1999; Purser & Renner, 1983) as a process that maximizes scientific literacy learning. Schoenback and Greenleaf (2009) believe, "engaged academic literacy learning is best supported through what is called an apprenticeship model" (p. 100). This study points to the fact that although we share common views, both Ross and I need to change some of our beliefs in order to implement disciplinary literacy. For example, we both need to re-conceptualize the separation of the modes of literacies. Brozo and Fisher (2010) suggest, "transforming beliefs requires that teachers have a genuine voice in planning, implementing, and evaluating improvement efforts" (p. 76). Given this and the success of Draper's (2008) participatory action research group, LaMonde and Rogers' (2007) transformation of pre-service teacher's notions of literacy through the arts and digital literacy, Shanahan and Shanahan's (2008) collaborative projects, and Thibodeau's (2008) study group, a shared approach to implementation is preferred.

More research is needed to better understand the discourses involved in each discipline. O'Brien, Stewart, and Moje's (1995) suggestion that "to adequately study disciplinary discourse communities, content literacy researchers should study disciplines over time to better understand the intersection of discourse forms, content knowledge, and pedagogy" (p. 457) still holds true. Teachers' contributions to this research should be respected and encouraged. More research also needs to be done on how assessment practices should reflect disciplinary literacy in the classroom. The impact of high stakes testing on disciplinary literacy should also be examined. Metacognition and critical literacy as comprehension has become an important component of The Ontario Curriculum, Grades 1-12, Language/English. Research should seek to explore the role of metacognition and critical literacy in disciplinary literacy. Research on disciplinary literacy should also give more attention to writing and oral communication. The experiences and reflections reported here indicate both Ross and I had more of a comfort with conceptualizing multimodal reading. Coker and Lewis (2008) consider writing to be "often overlooked" (p. 1) in research on adolescent literacy. The same appears to hold true for oral communication, despite the fact that one might argue that, "thoughtful, reflective… discussions… appear to be on the decline. They are now in a Sisyphean battle against the unmediated forces of Twittering, Facebooking, and YouTubing" (Barry, 2010, p. 43). Research could also investigate the potential of "gamelike learning" (Gee & Levine, 2010, p. 50) and how students can "use scientific information and tools to solve problems collaboratively" (p. 51) in order to deepen their knowledge of scientific concepts.

The Crossing

According to Freire, "reading the word is not preceded merely by reading the world, but a certain form of writing it or re-writing it, of transforming it by means of conscious practical work… This dynamic movement is central to the literacy process" (1983, p. 10). My journey to understanding scientific literacy has required me to move beyond a generalist skills-based view. A shift in thinking will require me to change my practice as a consultant. I now realize that the live demonstration lesson that I had planned is not an example of scientific literacy. I don't have a fixed idea yet as to what I will do; however, the focus of the lesson will revolve around a fundamental scientific concept such as sustainability and stewardship (Ministry of Education, 2008). The lesson will probably start with a big question that will require students to reflect on their own experience. From there we will read a few multimodal texts, starting with a tangible demonstration. At some point in the sequence of instruction we will discuss how each mode of representation works and promotes a particular way of understanding the concept we are studying. We will conclude by asking students to rethink their response to the initial question. Before I go any further in developing this live demonstration lesson, I am going to find a science teacher who can teach it with me, keeping in mind the learning needs of the students. I look forward to the collaboration and to discovering what the students, the teachers, and I will learn through the process.

References

Barry, C. (2010). From great texts – to great thinking. *Educational Leadership, 67*(6), 12-17.

Biancarosa, C., & Snow, C. E. (2006). *Reading next—A vision for action and research in middle and high school literacy: A report to Carnegie Corporation of New York* (2nd ed.). Washington, DC: Alliance for Excellent Education.

Brozo, W., & Fisher, D. (2010). Literacy starts with the teachers. *Educational Leadership, 67*(6), 12-17.

Beaufort, A. (2009). Preparing adolescents for the literacy demands of the 21st century workplace. In L. Christenbury, R. Bomer, & P. Smagorinsky (Eds.), *Handbook of adolescent literacy research* (pp. 239-255). New York, NY: The Guildford Press.

Beaufort, A. (2007). *College writing and beyond: A new framework for university writing instruction*. Logan, UT: Utah State University Press.

Coker, D., & Lewis, W. (2008). Beyond *Writing Next*: A discussion of writing research and instructional uncertainty. *Harvard Educational Review*, *78*(1), 241-251.

Conley, M. (2008). Cognitive strategy for adolescents: What we know about the promise, what we don't know about the potential. *Harvard Educational Review*, *78*(1), 84-106.

Draper, R. J. (2008). Redefining content-area literacy teacher education: Finding my voice through collaboration. *Harvard Educational Review, 78*(1), 7-39.

Education Quality and Accountability Office (EQAO). (2009). *Ontario secondary school literacy test: Released selections and test questions*. Toronto, Ontario, Canada: Queen's Printer for Ontario.

Fisher, I., & Ivey, G. (2005). Literacy and language as learning in content area classes: A departure from "every teacher is a teacher of reading." *Action in Teacher Education, 277*(2), 3-11.

Freire, P. (1983). The importance of the act of reading. *Journal of Education*, *165*(1), 5-11.

Graham, S., & Perin, D. (2007). *Writing next: Effective strategies to improve writing of adolescents in middle and high schools – A report to Carnegie Corporation of New York.* Washington, DC: Alliance for Excellent Education.

LaMonde, A., & Rogers, T. (2007). Infusing arts/multimedia into a secondary pre-service course on language and literacy across the disciplines as imaginative and critical practices. *Language & Literacy*, *9*(2), 1-28.

Lewis, C., & Del Valle, A. (2009). Literacy and Identity: Implications for research and practice. In L. Christenbury, R. Bomer, & P. Smagorinsky (Eds.), *Handbook of adolescent literacy research* (pp. 307-322). New York, NY: The Guildford Press.

Juel, C., Hebard, H., Park Haubner, J., & Moran, M. (2010). Reading through a disciplinary lens. *Educational Leadership, 67*(6), 12-17.

Knoble, M. & Wilber, D. (2009). Let's talk 2.0. *Educational Leadership, 66*(6), 20-25.

Masheno, B., & Lawson, A. (1999). Effects of learning cycle and traditional text on comprehension of science concepts at differing reasoning levels. *Journal of Research in Science Teaching, 36*(1), 23-37.

McConachie, S., Hall, M., Resnick, L., Ravi, A., Bill, V., Bintz, J. & Taylor. J. A. (2006). Task, text, and talk: literacy for all subjects. *Educational Leadership*, *64*(2), 8-14.

McKee, J., & Ogle, D. (2005). *Integrating instruction: Literacy and science*. New York, NY: The Guildford Press.

Meltzer, J., Cook Smith, N., & Clark, H. (2001). *Adolescent literacy resources: Linking research and practice.* South Hampton, NH: Centre for Resource Management, Inc.

Ministry of Education. (2009). *Grade 9 English, applied (ENG 1P): Reading graphic text*. Toronto, Ontario, Canada: Queen's Printer for Ontario.

Ministry of Education. (1999). *Ontario secondary schools, grades 9-12.* Toronto, Ontario, Canada: Queen's Printer for Ontario.

Ministry of Education. (2007). *The Ontario curriculum, grades 9 and 10 English*. Toronto, Ontario, Canada: Queen's Printer for Ontario.

Ministry of Education. (2008). *The Ontario curriculum, grades 9 and 10 Science*. Toronto, Ontario, Canada: Queen's Printer for Ontario.

Ministry of Education. (2003). *Think literacy: Cross curricular approaches, grades 7-12*. Toronto, Ontario, Canada: Queen's Printer for Ontario.

The New London Group. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review*, *66*(1), 60-92.

O'Brien, D., Stewart, R., & Moje, E. (1995). Why content literacy is difficult to infuse in the secondary school: Complexities of curriculum, pedagogy, and school culture. *Reading Research Quarterly*, *30*(3), 442-463.

Olsen, J., & Mokhtari, K. (2010). Making science real. *Educational Leadership, 67*(6), 12-17.

Purser, R., & Renner, J. (1983). Results of two tenth grade biology teaching procedures. *Science Education, 67*(1), 85-98.

Richardson, W. (2009). Becoming network-wise. *Educational Leadership, 66(6)*, 26-31.

Robinson, M., & Mackey, M. (2006). Assets in the classroom: Comfort and competence with media among teachers present and future. In J. Marsh & E. Millard (Eds.), *Popular literacies, childhood and schooling* (pp. 200-220). New York, NY: Routledge.

Schoenbach, R., & Greenleaf, C. (2009). Fostering adolescents' engaged academic literacy. In L. Christenbury, R. Bomer, & P. Smagorinsky (Eds.), *Handbook of adolescent literacy research* (pp. 98-112). New York, NY: The Guildford Press.

Shanahan, T., & Shanahan, C. (2008). Teaching disciplinary literacy to adolescents: Rethinking content area literacy. *Harvard Educational Review*, *78*(1), 40-59.

Sejnost, R., & Theise, S. (2001). *Reading and writing across content areas*. Thousand Oakes, CA: Corwin Press.

Thibodeau, G. (2008). A content literacy collaborative study group: High school teachers take charge of their professional learning. *Journal of Adolescent & Adult Literacy, 52*(1), 54-64.

Weeks, P. (2002). Old literacies, new literacies, visual literacies, techno-literacies and multi-literacies: How many literacies does it take to change a light bulb? *Impact*, *11*(2), 9-11.

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