

## ***Fostering Literacy Practices in Secondary Science and Mathematics Courses: Pre-service Teachers' Pedagogical Content Knowledge***

ANNE MURRAY ORR  
St. Francis Xavier University

JENNIFER MITTON KUKNER  
St. Francis Xavier University

D.J. TIMMONS  
Kativik School Board, Quebec

### *Abstract*

A significant number of high school students struggle to read textbooks and other course materials and to write successfully in content area courses such as mathematics and science (Kane, 2011). This paper investigates how pre-service teacher education can provide a strong literacy foundation for content area teachers. A pilot study, undertaken as part of an ongoing longitudinal study, examines how secondary pre-service teachers plan to infuse their teaching of secondary mathematics and science with literacy practices. This paper inquires into the perspectives of six mathematics and science pre-service teachers who were interviewed after completing a course in content area literacy. Pre-service teachers emphasized their growing awareness of how literacy strategies can enhance student learning in their specific subject areas.

### *Reading in the Content Areas: Contextualizing this Study*

Despite what is known about the crucial role of reading and its impact upon student learning, a significant number of students are unable to successfully read and make meaning from textbooks (McKenna & Robinson, 2014). Research suggests that the more students read, the more proficient they become (Krashen, 2004; Cunningham & Stanovitch, 1998); in addition, they strengthen their content knowledge as they read (Allington, 2001; Atwell, 2007). Yet many high school students struggle to read textbooks and other course materials and to write successfully in content area courses such as mathematics and science (Kane, 2011).

Because of this, mathematics and science teachers, among others, are being asked to more fully incorporate literacy strategies into their teaching. Ross and Frey (2009) found that while content area teachers were aware that comprehension of texts was important to student learning, participants felt they had little knowledge of how to teach for comprehension. To address this issue, professional learning opportunities are needed for both teachers and pre-service teachers (Kane, 2011). Canadian pre-service teacher education programs have been offering courses on literacy in content areas for a number of years. However, research into the effectiveness of pre-service teacher education in this area in Canada seems to be in its beginning stages; a scan of the literature reveals only one such study (Begoray, 2002). Literacy in the content areas in pre-service teacher education is the focus of the study described in this paper.

We are currently conducting a study examining how pre-service teachers infuse literacy into their teaching during field experience, teaching high school mathematics and

science courses with literacy practices learned in their Bachelor of Education (hereafter referred to as B. Ed.) program. Each winter we teach a course called *Literacy in the Content Areas* at our small Eastern Canadian university, with pre-service teachers who will teach secondary subjects ranging from mathematics and science to physical education and art. We hope to better understand the development of their teacher knowledge in the area of literacy. This paper highlights findings from interviews with six science and mathematics pre-service teachers conducted in the spring of 2012, the initial phase of our longitudinal study into the emerging literacy practices of science, mathematics, and other subject area pre-service teachers. Currently, we are in Year 2 of the study, and have completed two sets of interviews in the spring of 2013 with 19 pre-service teachers, as well as observations in eight secondary classrooms, where some of the participants in the 2013 phase of the study were teaching during their field experience. We plan to follow these teachers into their first two years of teaching, and to do the same with participants over the next four years, so that our sample size will be approximately 75 new teachers. The findings that are described in this paper from Year 1 of our study provide a starting point as we begin to analyze pre-service and new teachers' understandings of why and how they infuse literacy into their content area courses.

#### *Why Literacy is Relevant for all Teachers*

The meaning of the term literacy is evolving, as is reflected in the Government of Alberta's (2009) definition:

Literacy is more than the ability to read and write. It involves the knowledge, skills and abilities—the competencies—that enable individuals to think critically, communicate effectively, deal with change and solve problems in a variety of contexts to achieve their personal goals, develop their knowledge and potential, and participate fully in society (p. 6).

As emphasized in Alberta's Learning definition, literacy today is understood in broader terms and as one of the ways by which individuals relate with others in particular contexts in order to communicate, critically solve problems, develop knowledge, and fully interact in society. This broader definition acknowledges the multiple possibilities and situations in which individuals engage in relation to particular contextual requirements (Downer, Sabol, & Hamre, 2010; Johnson, 2010). The term literacy also refers to a combination of values and abilities to understand, think critically about, engage with, and improve society (Gee, 2001; Kane, 2011; Lind, 2008; UNESCO, 2008; Government of Alberta, 2009).

#### *The Evolving Nature of Literacy*

Thinking of literacy more broadly emphasizes that reading and writing are two of the many different ways that individuals interpret and communicate information and that different literacy practices are needed in response to particular situations and contexts (Begoray, 2002; Draper, 2002; McKenna & Robinson, 2014; Vacca & Alverman, 1998). Contemporary scholars have responded to the evolving nature of literacy, inviting us to recognize that literacy is more than reading and writing (Gee, 2007; Kalantzis & Cope

2011; Lind, 2008; Morocco, Aguilar, Bershad, Kotulam, & Hindin, 2008; New London Group 1996; UNESCO, 2008; Williams, 2006).

New literacies may encompass critical literacy (Alger, 2007; Keyes, 2011), critical media literacy (Robertson & Hughes, 2011) digital literacy (Kalantzis & Cope 2011; Gee & Hayes, 2011; Kim & Kamil, 2003), and content area literacy (McKenna & Robinson, 1990, 2014; Kane, 2011), among other literacies. Advocates of critical literacy endeavour to engage students in a critical examination of society, one that calls for empathy and compassion, preparing them to become engaged world citizens (Alger, 2007; Keyes, 2011). Critical media literacy strategies encourage students to think about sources of information as ideologically biased, representing selected points of view while omitting others (Robertson & Hughes, 2011). Expertise in such strategies is becoming increasingly important as multimedia technology and online sources proliferate. In order to participate fully in today's society, students must be fluent in digital literacy, as multimedia proficiency requires additional competencies to those required for reading traditional texts (Gee & Hayes 2011; Kane, 2011; Kim & Kamil, 2003; Lankshear & Knobel, 2003). These competencies can be developed through literacy instruction in content areas such as science and mathematics, among others.

### *Content Area Literacy*

Content area literacy is the ability to acquire understandings of, and think critically about, new content in a discipline using reading, writing and multiple other forms of representation, content-specific literacy skills and attitudes, and prior knowledge (Draper, 2002; Heller & Greenleaf, 2007; Kane, 2011; McKenna & Robinson, 1990). The conception of content area literacy as one aspect of literacies requires teachers to rethink their approach to literacy instruction in schools (Au, 1998; Barr, Watts-Taffe, & Yokota, 2000; Beers, 2003; Gee, 2008; Lankshear & Knobel, 2003; Olson, 2011; Robertson & Hughes, 2011) as content area classrooms place certain literacy demands upon students and content literacy enables students to better learn content knowledge (McKenna & Robinson, 2014). This brings sharply into focus the literacy practices of content area teachers and how they need to be highly literate in their particular disciplines and discourse communities (Kane, 2011). In contrast, pre-service and beginning teachers may not understand literacy as a "set of social practices" (Botzakis & Malloy, 2006; New London Group, 1996), and lack awareness of its pervasive impact on students. This conception of the role of literacies in learning emphasizes the importance of including a focus on content area literacy in pre-service teacher education programs.

### *Content Area Literacy Enhances Learning across the Curriculum*

The cross-curricular importance of literacy is highlighted by a number of studies that demonstrate the relationship between literacy and content area learning (Alvermann, Rezak, Mallozzi, Boatright, & Jackson, 2011; Lee, Penfield, & Buxton, 2011; Moje, Ciechanowski, Kramer, Ellis, Carillo, & Collazo, 2004). Mathematics and science teachers, among others, are being encouraged to think of themselves as teachers of literacy and to bring literacy practices into their teaching (Cecil & Gipe, 2009). Shanahan and Shanahan (2008)'s model of disciplinary literacy highlights how teachers in particular subjects have expertise to share with students about literacy practices related to

their field. For example, Seixas and Peck (2004) trace elements of historical thinking with which students might become familiar as part of a disciplinary literacy in history.

Individuals with less proficiency in literacy are at an enormous cultural, social, political and economic disadvantage (Alger, 2007; Government of Alberta, 2009; UNESCO, 2008), and approaches to literacy development in schools have effectively become an issue of social justice (Alger, 2007, 2009; Freire, 1997; Robertson & Hughes, 2011; Keyes, 2009). As the use of standardized assessments such as the Programme for International Student Assessment (PISA) to measure students' literacy proficiency increases locally, nationally, and internationally, teacher accountability for student literacy achievement in all subject areas is brought sharply into focus (Cheng, Kliner & Zheng, 2009). Math, science, and social studies teachers, among others, are being asked to more fully incorporate literacy strategies into their teaching in school boards across Canada.

Because literacy is important in all subject areas, content area teachers can play a significant role in their students' literacy development (Alger, 2007, 2009; Draper, 2002; Lind, 2008, Heller & Greenleaf, 2007). A number of studies have shown the importance of teaching students skills, strategies, and attitudes that foster high level comprehension and critical thinking in content areas (Duke, Pressley, & Hilden, 2006; Graesser, McNamara, & Louwerse, 2003; Sweet & Snow, 2002; Taboada, Guthrie, & McRae, 2008). One approach to exploring teachers' developing abilities to infuse literacy in their content area teaching practices is through the lens of pedagogical content knowledge (Shulman, 1986).

#### *Literacy Practices and Pedagogical Content Knowledge*

Shulman (1986) defined three categories of content knowledge as he considered the question, "How might we think about the knowledge that grows in the minds of teachers, with special emphasis on content?" (p. 9). These categories are: "(a) subject matter content knowledge, (b) pedagogical content knowledge, and (c) curricular knowledge" (p. 9). Subject matter knowledge refers to the depth of understanding teachers have of their subject matter, such as mathematics, and its organization. Pedagogical content knowledge is defined by Shulman as "embod[ying] the aspects of content most germane to its teachability" (p. 9). Curricular knowledge is knowledge of the curriculum programs that set out expectations for learners in each subject area and across grade levels, and the variety of possible curriculum materials that can be used in teaching and learning in those subject areas.

Here we focus on Shulman's (1986) second category, pedagogical content knowledge, which has strong relevance for our study. Shulman includes in this category knowledge of:

the most useful forms of representation of those [topics to be taught in the subject area and] ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that make it comprehensible to others. (p. 9)

This requires a deep understanding of the subject, curricular development, and how students learn concepts and topics particular to the subject. Additionally, Shulman suggests pedagogical content knowledge incorporates “an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons” (p. 9).

We have applied Shulman’s (1986) conception of pedagogical content knowledge to our study of pre-service and new teachers’ literacy practices in three ways. Firstly, we understand pedagogical content knowledge as closely related to literacy in the various content areas. Shulman describes the understanding of which forms of representation best suit the teaching and learning of topics in one’s subject area as one aspect of pedagogical content knowledge, and we see this as part of literacy in one’s content area. For example, deciding among the use of a diagram, a descriptive text, or a video clip to teach parts of a plant cell in biology (or deciding all are important) calls for a knowledge about which forms of representation will enable students to better learn about the topic. Expanding awareness of different possibilities for representing concepts in teaching is an important focus of the B. Ed. course we teach, *Literacy in the Content Areas*, and we understand it as a feature of literacy across subject areas. It follows that teaching that incorporates appropriate choices of representation means high school students in those courses are more likely to become more literate in that subject area. In our study we inquire into teachers’ facility in choosing appropriate forms of representation for teaching topics in their high school mathematics or science courses.

Secondly, we are drawn to Shulman’s (1986) contention that pedagogical content knowledge includes an understanding of what students bring to the learning of new content. How do pre-service and new teachers gain insight into what background knowledge their students bring to bear on a new topic in their mathematics or science course?

Thirdly, Shulman’s (1986) central question, “How might we think about the knowledge that grows in the minds of teachers, with special emphasis on content?” (p. 9) reminds us that teacher knowledge, including pedagogical content knowledge, grows organically over time as teachers’ experiences acquire more depth and breadth. It is impossible for pre-service teachers to fully develop the pedagogical content knowledge they need during the relatively short span of teacher education programs. Rather, as Grossman, Valencia, Evans, Thompson, Martin and Place (2000) suggest, the goal is to help them become “adaptive experts” (Hatano and Inagaki, 1986) who will continue to grow and develop their pedagogical content knowledge throughout their careers. In conversations with our participants, we wanted to find out how they are developing pedagogical content knowledge at this early stage of their careers, with a plan to follow these teachers into their first two years of teaching to learn more about how this knowledge grows.

While pre-service teachers are usually required to take courses on content area literacy instruction, many pre-service teachers feel they are neither responsible for, nor capable of, teaching students aspects of literacy related to their subject areas (Scharlach, 2008). Instead, they frequently abandon strategies learned in teacher education programs, adopting the often traditional sociocultural practices of schools observed during their first year of teaching (Alger, 2009; Bean, 1997; Begoray, 2002; Grisham, 2000; O’Brien &



Stewart, 1990; Smagorinsky, Wilson, & Moore, 2011). Hammerness, Darling-Hammond, Grossman, Rust, and Schulman (2005) believe that such traditional teaching practices often produce knowledge and skills lacking utility outside of the classroom. Conversely, other research suggests that pre-service teachers are influenced by their teacher education programs (Grisham, 2000; Grossman et al., 2000). Grossman et al. indicate that early career teachers make further use of pedagogical tools learned in teacher education programs after their first year of teaching, thus problematizing claims by researchers about limitations on what pre-service teachers learn during their teacher education program. They also note that of all the pedagogical knowledge learned in teacher education programs, fostering the attitude to embrace continual future development may be the most important learning of all. Recent studies also indicate that many teacher educators, teachers and principals believe that pre-service teachers in Canada receive inadequate instruction in teaching and assessing literacy (Botzakis & Malloy, 2006; Bruinsma, 2006) and that Canadian elementary teachers are often better equipped to teach and assess literacy than secondary teachers (Botzakis & Malloy, 2006).

Like Cochran-Smith, McQuillan, Mitchell, Gahlsdorf, Terrell, Barnatt, D'Souza, Jong, Shakman, Lam and Gleeson (2012), who conducted a longitudinal study of new teachers' practices, in this study we are beginning to explore participants' teaching experiences as they develop their pedagogies and their pedagogical content knowledge as teachers of literacy in mathematics and science courses. Our study will be on a smaller scale than that of Cochran-Smith et al. However we anticipate that continuing to talk with teachers from the last days of their B. Ed. programs into their first two years as teachers will provide a deeper understanding of how these literacy pedagogies and practices are shaped, and how teacher education programs can facilitate the process.

#### *Exploring Pre-Service Teachers' Developing Content Knowledge about Literacy*

A number of researchers indicate the need for more longitudinal studies of pre-service teachers, which follow them into their careers as teachers (Alger, 2007; Bean, 1997; Cochran-Smith et al., 2012; Caudle & Moran 2012; Grisham, 2000; Grossman et al., 2000; Hoffman, Roller, Maloch, Sailors, Duffy, Beretvas, & the National Commission on Excellence in Elementary Teacher Preparation for Reading Instruction, 2005; Jones & Enriquez, 2009). We are currently in the second year of a five-year longitudinal study in which we explore beginning science, mathematics, and social studies teachers' literacy practices and their evolution over time. We are endeavoring to understand the topic from the perspective of beginning teachers (Bogdan & Biklen, 1998) and as part of our ongoing study have begun to conduct classroom observations and personal interviews with pre-service and new teachers in order to learn more about the "multiple realities" (Creswell, 2007, p. 16) of teachers' experiences. Through our qualitative research inquiry into the development of beginning teachers' literacy teaching practices, the experiences and voices of individuals provide vital insight into how these teachers "interpret their experiences" (Merriam, 2009, p. 5). In what follows we focus specifically upon findings from Year 1 of the study, with new mathematics and science teachers only.

In the spring of 2012, we conducted the first phase<sup>1</sup> of our longitudinal study, interviewing six recently graduated mathematics and science teachers, whom we had taught in a course called *Literacy in the Content Areas* in the winter of 2012 in the Bachelor of Education program at our university in Eastern Canada. Potential participants had already graduated from the B. Ed. program before being approached for interviews. Six agreed to be interviewed and two did not. Regarding ethical concerns about how our relationships with participants may have influenced their responses, since the course we taught was completed and marks were submitted several months earlier, the relationship we had with the participants at this point did not involve a difference in power. We invited participants to talk with us about their learning in the course and their attempts to integrate literacy into their mathematics and science teaching practices during their final six-week field experience in March and April 2012. These interviews took place in July 2012; some were face-to-face and others were by phone or Skype. The interviews were semi-structured, approximately 30 minutes in length (the interview guide is included in Appendix A), and were transcribed by a research assistant.

During data analysis, we analyzed the transcriptions along with our field notes from the interviews. As we read and re-read participants' descriptions of their teaching experiences, we focused upon pre-service teachers' understandings of how literacy activities were used to create opportunities for high school students to better understand content area knowledge and concepts particular to the mathematics or science course. We investigated how the infusion of literacy activities demonstrated pre-service teachers' understandings of the teaching process, one of the three aspects of pedagogical content knowledge Shulman (1986) defined.

The process of data analysis involved inductively analyzing and comparing the interview data (Creswell, 2007; Merriam, 2009). We individually made notes of key ideas or themes that we saw emerging and repeating across the interview transcripts and field notes. As part of this process, we also developed codes for the ideas we saw frequently in the data. For example, when one author began to note authentic assessment practices as a recurring theme in her reading of the transcripts, she used the acronym AA in the margin beside any references to this topic she saw in the transcripts and field notes. These codes were developed based on the frequency with which all six participants mentioned topics and how often we found these topics individually as we separately analyzed the transcripts. Initially we had approximately twelve potential themes among us. We then met several times and discussed these themes, finding much congruence and some dissonance in our analyses. Some themes did not have enough rich data to support their inclusion in our findings. That is, they may have been mentioned only three or four times throughout the interviews and field notes. As we discussed the themes and returned to the data we determined there were four themes that recurred repeatedly and appeared significant. In what follows we describe the four main themes and include excerpts from transcripts of the interviews grouped around the four themes.

---

<sup>1</sup> We had not initially planned to interview participants until the winter of 2013, but were encouraged by the senior administration of our university to begin the interview process earlier, when we received internal funding from our institution. We are very grateful to the university for this funding. We began with a small sample size in 2012. As noted in the introduction, in 2013 and in subsequent years, we have interviewed /plan to interview larger numbers of teachers.

*Our findings: Awakening to possibilities and challenges  
of infusing literacy across math and science courses*

The pre-service teachers we interviewed in 2012 had strong views about the importance of incorporating relevant literacy practices into their teaching. Each one described changes in their beliefs and/or understandings, in part as a result of completing the *Literacy in the Content Areas B. Ed.* course, and provided a number of examples of how they more or less successfully attempted to integrate some literacy practices during their six-week field experience in the spring of 2012. These pre-service teachers also discussed their expanding understandings of integrating literacy into mathematics and science courses, and their developing sense of how literacy can contribute to authentic assessment and learning in mathematics and science.

*Pre-service teachers' growing awareness of possibilities for infusion of literacy  
throughout content area courses*

After completing the final field experience of the B. Ed., the pre-service teachers demonstrated a growing awareness of the imperative for literacy to be infused throughout content area courses, putting particular emphasis upon how the infusion of literacy into the teaching of content created better learning opportunities for students in their course work and in everyday life situations. Participants also demonstrated a more sophisticated understanding of metacognition and the ways they felt literacy strategies enabled students to express their learning as it was happening:

Literacy is important...for everyday life outside of school. So after students are done with high school and, in really any kind of job, you really need literacy to even express that you have a knowledge of math. So you need to communicate your ideas. So I found that...was a proof for me that their math literacy was really important. (Participant 2<sup>2</sup>, Pre-service math teacher)

My perception of literacy [shifted] to a point where it was more about getting to the learning and what that means in relation to content literacy...getting into those deeper levels of understanding...those different [levels] analyze, synthesize, that type of thing. I like to focus on that when it comes to literacy because it gets students thinking more [deeply] about what is a “protist” [for example] and explaining why we classify them this way. (Participant 5, Pre-service science teacher)

This pre-service teacher uses the example of how she might help students learn about the term “protist” within the context of understanding how organisms are classified to illustrate how she sees literacy as relevant for her in a high school biology class.

As part of infusing literacy into their teaching, pre-service teachers talked practically about how they used some of the literacy strategies taught and demonstrated in the *Literacy in the Content Areas* course. Participants often discussed the successes they experienced teaching students by using writing to learn strategies (Daniels,

---

<sup>2</sup> We refer to the six participants as Participants 1, 2, 3, 4, 5 and 6. The participants were interviewed on the following dates: Participant 1: July 18, 2012, Participant 2: July 6, 2012, Participant 3: July 3, 2012, Participant 4: July 4, 2012, Participant 5: July 6 and Participant 6: July 4, 2012.



Zemelman, & Steineke, 2007) like exit slips, writing breaks, brainstorming and drawing. One participant, a pre-service mathematics teacher, talked about encouraging drawing in the teaching of high school mathematics. “One of the units we were doing was polynomials [using] the algetiles and they could draw the parts out, because this is how you can see how some of this works: use the tiles and you can draw it too” (Participant 1, Pre-service math teacher). In this example, the pre-service teacher notes how using drawing and manipulatives helped students work toward an understanding of mathematics concepts. This reflects a key point of the B. Ed. *Literacy in the Content Areas* course: that literacy strategies can be tools to enable deeper understanding of course content.

As well as the writing to learn activities, the B. Ed. *Literacy in the Content Areas* course focused on larger writing projects that could be integrated into high school mathematics and science. In a grade 10 science ecosystems unit, a pre-service science teacher engaged students in a multi-genre project. She described her thinking about the assignment:

And I got them to do a multi-genre project where they had to complete a web quest first of all, in which they had to answer ten questions. And then on a piece of looseleaf, they had to make a [graphic organizer] about three different ecosystems that they were studying. So the next part of the web quest was to create a map of the world and put where those ecosystems are in the world. And then the third part was kind of their choice, they could decide what they wanted to do. I had a rubric and I wanted to see that they kind of understood what their ecosystem looked like and what their ecosystem was...[and] the interactions within their ecosystems. One student did a painting for the third part of her project.” (Participant 6, Pre-service science teacher)

This pre-service teacher’s comment reflects the practical nature of B. Ed. *Literacy in the Content Areas* course, with its emphasis on giving students teaching ideas such as the multi-genre project and other larger writing projects. This pre-service science teacher saw the multi-genre project as a useful activity she could import into her Science 10 course. At the same time, due to the emphasis that participants placed upon the practical nature of literacy activities, we also looked closely at whether they were able to discuss the reasons why they would use these ideas, the philosophy and learning principles behind literacy in their content areas. In the next section, we explore this question and look at pre-service teachers’ expanding notions of literacy in math and science.

#### *Pre-Service Teachers Develop Expanded Notions of Literacy in Math and Science*

In response to the B. Ed. *Literacy in the Content Areas* course and the opportunity to infuse literacy practices into the final field experience of the B. Ed. program, pre-service teachers spoke not only about practical attempts to include literacy strategies as part of their teaching practices, they also noted how their understandings of literacy in math and science had expanded. A number emphasized that at the beginning of the B. Ed. course they initially thought literacy “was reading and writing and getting those skills, and that it wasn’t something that was my responsibility” (Participant 5, Pre-service science teacher). More than one pre-service teacher noted that their understandings of

literacy began to broaden in the B. Ed. course and put particular emphasis upon literacy strategies as “rich meaningful activities for the students that went beyond just knowing how to read and write; it was more about getting to the learning and what that means in relation to content” (Participant 5, Pre-service science teacher).

One pre-service teacher described how her expanding understanding of literacy helped her see its place in her high school mathematics class, as she:

had at least a couple students in my math practicum that had disabilities around like English and writing but one of the guys in particular was really good in math so I was kind of hesitant to make him write out a whole bunch of things because it might lower his confidence. Knowing that math literacy isn't always about writing, but it's also about graphic organizers and about speaking, like telling people how you understand this or explaining a process, was helpful as well. (Participant 2, Pre-service math teacher)

As part of her expanded understanding of literacy, another pre-service teacher noted the difference between being literate and being literate in a particular content area, particularly when:

teaching very abled students and how they probably consider themselves very literate, which they are and they have high levels of literacy, but in terms of that content literacy [in biology], how does it go beyond just knowing what it is, to really understanding what you're talking about...that this activity that we're doing, it's helping your literacy in biology right now... giving the students the opportunity to read it, summarize it on their own, get it into their own heads without me just telling them the important points. (Participant 5, Pre-service science teacher)

Pre-service teachers' comments suggest they understand the relationship between the infusion of literacy and the opportunity for increased comprehension of content that is particular to mathematics and science. They seemed to see the teaching of literacy strategies as beneficial for student learning beyond the classroom, helping them to think like scientists and mathematicians and to demonstrate their thinking:

All the strategies we learned, that was all amazing. I wasn't expecting that. I don't really know what I was expecting but I know that it wasn't that. I honestly didn't think there were even remotely that many things that you could do to infuse literacy in your content area. (Participant 4, Pre-service math teacher)

Participants began to develop a repertoire of literacy strategies relevant to their content areas, but also broadened their knowledge and definitions of literacy. Additionally, this sometimes benefitted the cooperating teachers in whose classrooms the pre-service teachers worked during field experience, as the following excerpt highlights:

So I would say [the course] was incredibly useful. And I would say, too, that the teacher, my cooperating teacher this year, anytime I would try some of them, she would say “Oh that was cool” and take a mental note of it because it was something that she hadn’t thought of or hadn’t used yet. And you know in the end, she thought, “Hey, those are some really cool activities that you did and I’m going to try those. (Participant 5, Pre-service science teacher)

This was an unexpected byproduct of pre-service teachers’ beginning efforts at incorporating literacy into their teaching during field experience, and one which suggests an intriguing path this research study may expand into, inquiring into more experienced teachers’ use of literacy practices in mathematics and science courses.

*Pre-Service Teachers’ Beginning Understandings of How Literacy Can Contribute to Authentic Assessment in Mathematics and Science*

In conversation, it became evident that participants were developing an understanding of how the literacy strategies they employed in mathematics and science classrooms could add more depth to their assessment of student learning, as well as to students’ self-assessment of their learning. In a Grade 10 science unit on the nervous system, a pre-service science teacher had students watch a short video clip and write or draw about what they knew about sight, so that she *and the students* could get a sense of their knowledge on this topic midway through the unit. She explained that she told the students:

Here’s a chance for you to see what you can do and see what you’ve learned for yourself as well as for me to see what you’ve learned. Maybe we need to talk about sight in a different way and maybe we need more diagrams and that type of thing. And as soon as they realized that it would be a benefit to their learning, it was great. (Participant 5, Pre-service science teacher)

Participants also spoke of how they were starting to see informal assessments such as the one in the example above as useful in informing their lesson planning and instruction. Another pre-service science teacher commented that, “...when I told them [students] it wasn’t graded and I just wanted to know, then they were like, okay...I can be free to write...write whatever I want... They didn’t realize that I actually wanted to just see what they knew as opposed to testing them” (Participant 4, Pre-service science teacher). This remark seems to indicate that this pre-service teacher may be navigating thorny questions around grading student work in ways that value student learning as a developmental process, rather than considering the grade as an end in itself.

On more formal assessments such as math tests, one participant noted that, for her, a student showing they can understand the math concepts is the bottom line:

I like to include questions like: make your own word problem for two to the power of x equals eight. Students always groan about those types of questions but it really shows that they understand what the equation means or what they’re actually solving for. So I like to include them because it shows me who really understands what we’re talking about. (Participant 2, Pre-service math teacher)

Including a literacy-based question like making one's own word problem requires being able to think about math concepts from different angles and to transfer learning into new situations. Again, for this pre-service teacher, the focus appears to be on students' deeper understanding of course content.

Although participants acknowledged their growing confidence in assessment, particularly in how the infusion of literacy practices created opportunities for them and the students they taught to observe their deeper understanding of content, one pre-service teacher noted the ways in which she needed to improve her own authentic assessment practices explaining that in the future she would "actually record how students are doing so I can see their progress throughout" (Participant 2 Pre-service math teacher).

### *Uncertainties and Challenges around Integrating Literacy into Mathematics and Science Courses*

As pre-service teachers talked about their field experiences, they described a number of challenges experienced as they attempted to infuse literacy into mathematics and science courses. Firstly, the issue of time and the pressures to "cover the content" loomed large. One pre-service teacher noted, "There are a lot of outcomes. And a lot of students find the courses, they find it very difficult and a lot of times you do have to spend extra time on things and there isn't enough time [to integrate literacy]" (Participant 6, Pre-service science teacher). Another stated, "It is hard to infuse [literacy] when your content is just so overwhelming" (Participant 4, Pre-service math teacher). Building on this theme, another said, "Um, ah it's just [literacy], it seems that sometimes it can [be] a little time consuming. And I know we've talked about this in class quite a bit, that finding time, it is important. But still the pressure of all the outcomes [is overwhelming]" (Participant 3, Pre-service science teacher). Clearly, the perceived time/content factor affected these pre-service teachers' confidence as they began to try to integrate literacy into their teaching, as it has for new teachers for many years (Lortie, 1975).

However, it seemed some did not allow this issue to prevent them from trying. Instead, as one pre-service teacher noted, she recognized the need to "...kind of start out with literacy, like, kind of start out small in math [or science] class..." (Participant 2, Pre-service science teacher). She seemed to indicate that, despite the challenges of time and content pressures, she would gradually build literacy into her teaching once she was a teacher in her own classroom, after completing her B. Ed.

Another challenge pre-service teachers highlighted was the lack of modeling of literacy strategies in math and science courses by the cooperating teachers with whom they were placed during their field experience. One participant recalled, "...but like I didn't even see a content area literacy thing across the science department level of the whole school" (Participant 6, Pre-service science teacher). As well, another noted he could not recall his own teachers using such approaches when he was in high school. "...[integrating literacy is] a different approach but I think it's the right approach, so. Um, it's just a matter of perfecting the practice, I guess, and getting used to it. Because it's not really something that a lot of teachers have used in my experience growing up..." (Participant 3, Pre-service science teacher).

Some pre-service teachers articulated uncertainties around their confidence as readers and writers, which caused them to feel self-doubt when attempting to infuse

literacy into mathematics and science courses. The following statement shows the ambiguity felt by a number of pre-service teachers. “Like, I hate essay writing but I would absolutely encourage it and expect students to do it so, um, so yeah. Just giving them opportunities and almost, not necessarily forcing them, but...encouraging them...” (Participant 4, Pre-service math teacher). With a different perspective on this issue another pre-service teacher said, “I didn’t use um essays at all, now that I think about it...Um no, I didn’t use essays at all. But basically the reason why I didn’t use essays probably like when I tested or...even in tests...was probably my uncomfortability with actually correcting one” (Participant 6, Pre-service science teacher). In both cases, the pre-service teachers’ lack of confidence in essay writing had an impact on their pedagogies and literacy practices, causing one to avoid assigning essays at all, while the other felt she should assign them but seemed unclear about how to support students as they wrote essays.

Not only were some pre-service teachers lacking in confidence about their literacy, they also found students filled with uncertainty about and therefore, resistance to, literacy in mathematics and science courses. “But I did run into, I, I consistently ran into [students asking]... Is this right? Is this what you want? Is this what you want it to look like?” (Participant 5, Pre-service science teacher). This same pre-service teacher also noted, “And yeah, people just think that [literacy] belongs in a different class. Like this is just where that belongs. Just like a math book or a calculator belongs in a math class. It’s just like it, it just seems like it’s...that’s sort of where it’s best suited.” It seemed many students did not understand the place of literacy in their mathematics and science courses, and wanted clarity from pre-service teachers regarding assignments that included some aspect of literacy. This was not an unreasonable desire, but one that pre-service teachers found onerous, perhaps because of their own uncertainties about their literacy practices and about how to assess the assignments.

According to pre-service teachers, students and cooperating teachers did not necessarily see a place for literacy in mathematics and science classes. This resistance sometimes led to issues around grading. “How do you get them to do something that’s not being graded? I found that was quite an issue. It was hard to get them to do something that wasn’t being graded” (Participant 4, Pre-service math teacher). Pre-service teachers struggled with how to value literacy in a paradigm which seemed not to incorporate this aspect of learning into the grading system. One pre-service teacher spoke of her own awareness of the need for literacy in her subject areas, but could not reconcile this with the classrooms she encountered in school. “They [literacy strategies] do have a place, um because...if students have a deeper understanding going into a test, then chances are they’re going to do better on the actual test” (Participant 1, Pre-service math teacher). This comment reflects the idea that pre-service teachers appear ready to incorporate literacy strategies into their science and mathematics classrooms, and see why this is important. However, the challenges of schools that appear not to support the integration of literacy in science and mathematics courses is a stumbling block as these new teachers develop their pedagogies and make decisions about the place of literacy in their classrooms.



*Discussion: Enhancing Literacy Practices and Developing  
Pedagogical Content Knowledge*

The previous sections describe some of the ways six new teachers were beginning to develop their pedagogical content knowledge (Shulman, 1986) in the final field experience of their B. Ed. program, after completing the *Literacy in the Content Areas* course in their final term. We found these teachers willingly supported the idea of integrating literacy in mathematics and science courses, although their successes were somewhat uneven as they attempted to make this a regular part of their teaching practice.

All six participants in our study talked about examples of how they had integrated literacy into their teaching, and how they believed in the need to include literacy in their teaching practices. One of the key aspects of Shulman's (1986) definition of pedagogical content knowledge concerns teachers' abilities to choose from a variety of ways to represent topics as they teach students new concepts. Comments from the participants indicate they had a broader repertoire of ways to represent topics in their subject areas as a result of taking the *Literacy in the Content Areas* course, and they were able to draw upon this repertoire during their field experience. For example, the pre-service science teacher who had students complete a multi-genre project on ecosystems described how she felt this choice of representation enabled Grade 10 students to gain a solid understanding of the topic. We see participants' use of drawing, graphic organizers, diagrams, and other ways of representing knowledge that they had opportunities to learn about and practice in the B. Ed. course, as an expression of their developing pedagogical content knowledge.

Participants also discussed challenges they experienced, which they attributed to their uncertainties about their own reading and writing abilities, student resistance, lack of experienced teacher models, and the overwhelming number of outcomes to address in their courses. Earlier, we noted it is challenging, if not impossible, for pre-service teachers to fully develop their pedagogical content knowledge during their B. Ed. programs. As we spoke with our participants, we could see that while they are cultivating their pedagogical content knowledge, this is a process that will continue over the years of their careers, as they become "adaptive experts" (Hatano and Inagaki, 1986) and find ways to address the challenges they named during interviews.

In spite of these challenges, we observed these new teachers having expanded notions of what learning can look like and how understanding of content can be enhanced through infusing literacy into their science and mathematics courses. Comments about how particular students benefitted from approaches that incorporated literacy into teaching and learning indicated that this emphasis helped pre-service teachers consider the background knowledge, strengths and challenges students bring to their learning about new topics. For example, one participant noted that a student in her math class had learning disabilities but her expanded knowledge about how to infuse her math lesson with literacy strategies ("...it's not always about writing...") enabled her to make decisions that enhanced this student's learning. Another participant found that her expanded knowledge of how content can be enhanced through literacy strategies allowed her to address the learning of "very abled students" in her biology class by providing opportunities for higher level thinking about the topics she taught. Shulman's (1986) description of pedagogical content knowledge included an awareness of the background knowledge of students and "what makes the learning of specific topics easy or difficult"

(p. 9). In comments from participants, such as those noted here, we observed how expanded conceptions of how literacy can enrich learning in content areas seemed to give pre-service teachers a heightened awareness of the need to consider students' background knowledge in their teaching, thereby fostering the growth of their pedagogical content knowledge.

Finally, we noted the depth of some participants' awareness of how literacy can contribute to authentic assessment in mathematics and science. This was perhaps one of the most surprising findings. We did not expect these new teachers to have such relatively sophisticated conceptions of assessment, as some of them demonstrated their understanding of the need for students to be able to represent their learning in a variety of ways and to be self-assessors at the same time, metacognitively considering their own learning practices. Shulman (1986) does not discuss assessment directly, but he asks, "How do teachers decide...how to question students about [the topics being taught] and how...[do they] deal with problems of misunderstanding?" (p. 8) The new teachers we interviewed appeared to be endeavouring to address these questions head on in their teaching, which seems to reflect a deepening pedagogical content knowledge.

In this section, we considered the participants' comments using Shulman's (1986) conception of pedagogical content knowledge. From the findings discussed in this paper, we suggest pre-service teachers' pedagogical content knowledge seems to have been shaped to some degree by their experiences in the *Literacy in the Content Areas* course and in the subsequent six-week field experience.

#### *Conclusion: Promising Perspectives and Challenging Contexts*

Mathematics and science teachers across Canada, as well as teachers in other content areas, are being asked to more fully incorporate literacy strategies into their teaching. This paper provides a glimpse into how some pre-service teachers at one institution appear to both embrace and struggle with this direction. Considering the development of the participants' literacies as teachers in their subject areas and their pedagogical content knowledge provided a framework for us to understand their growth. We hope to contribute to the field of research on literacy instruction in the content areas in Canadian pre-service teacher education programs by our ongoing inquiry, and we feel the results of this study offer a thought-provoking beginning.

#### *References*

- Alvermann, D. E., Rezak, A. T., Mallozzi, C. A., Boatright, M. D., & Jackson, D. F. (2011). Reflective practice in an online literacy course: Lessons learned from attempts to fuse reading and science instruction. *Teachers College Record*, 113(1), 27–56.
- Alger, C. L. (2007). Engaging student teachers' hearts and minds in the struggle to address (il)literacy in content area classrooms. *Journal of Adolescent & Adult Literacy*, 50(8), 620-630.
- Alger, C. (2009). Content area reading strategy knowledge transfer from preservice to first-year teaching. *Journal of Adolescent & Adult Literacy*, 53(1), 60-69.
- Allington, R. L. (2001). *What really matters for struggling readers: Designing research-based programs*. New York: Longman.

- Atwell, N. (2007). *The reading zone: How to help kids become skilled, passionate, habitual, critical readers*. New York: Scholastic.
- Au, K. H. (1998). Social constructivism and the school literacy learning of students of diverse backgrounds. *Journal of Literacy Research*, 30(20), 297-319.
- Barr, R., Watts-Taffe, S., & Yokota, J. (2000). Preparing teachers to teach literacy: Rethinking preservice literacy education. *Journal of Literacy Research*, 32(4), 463-470.
- Bean, T. W. (1997). Preservice teachers' selection and use of content area literacy strategies. *The Journal of Educational Research*, 90(3), 154-163.
- Beers, K. (2003). *When kids can't read: What teachers can do*. Portsmouth, NH: Heinmann.
- Begoray, D. (2002). Not just reading anymore: Literacy, community and the pre-service teacher. *English Quarterly*, 34(3-4), 39-45.
- Bogdan, R. C., & Biklen, S. K., (1998). *Qualitative research for education: An introduction to theory and methods* (3<sup>rd</sup> ed.). Needham Heights, MA: Allyn and Bacon.
- Botzakakis, S., & Malloy, J. A. (2006). International reports on literacy research: Australia, Canada, Chile, Estonia, Hong Kong, Iran, Nigeria, Oman. *Reading Research Quarterly*, 41(1), 132-137.
- Bruinsma, R. W. (2006). Are they ready to teach reading and writing? The preparation of preservice elementary language arts teachers in Canadian universities. *The Alberta Journal of Educational Research*, 52(1), 99-102.
- Caudle, L. A., & Moran, M. J. (2012). Changes in understandings of three teachers' beliefs and practice across time: Moving from teacher preparation to in-service teaching. *Journal of Early Childhood Teacher Education*, 33(1), 38-53.
- Cecil, N. L. & Gipe, J. P. (2009). *Literacy in grades 4-8: Best practices for a comprehensive program* (2<sup>nd</sup> ed.). Scottsdale, AZ: Holcomb, Hathaway Publishers.
- Cheng, C. Kliner, D. A., & Zheng, Y. (2009). Examining students' after-school literacy, activities and their literacy performance on the Ontario secondary school literacy test. *Canadian Journal of Education*, 32 (1). 118-148.
- Cochran-Smith, M., McQuillan, P. Mitchell, K., Gahlsdorf Terrell, D., Barnatt, J. D'Souza, L., Jong, C., Shakman, K., Lam, K., & Gleeson, A. (2012). A longitudinal study of teaching practice and early career decisions: A cautionary tale. *American Educational Research Journal*. 1-37. DOI: 10.3102/0002831211431006.
- Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2<sup>nd</sup> ed.). Los Angeles: Sage Publications Ltd.
- Cunningham, A. E. & Stanovitch, K. E. (1998). What reading does for the mind. *American Educator*, Spring/Summer, 8-15.
- Daniels, H., Zemelman, S., & Steineke, N. (2007) Content-area writing: Every teacher's guide. Portsmouth, NH: Heinemann.
- Downer, J., Sabol, T. J., & Hamre, B. (2010). Teacher-child interactions in the classroom: Toward a theory of within-and cross-domain links to children's developmental outcomes. *Early Education and Development*, 21, 699-723.

- Draper, R. J. (2002). Every teacher a literacy teacher? An analysis of the literacy-related messages in secondary methods textbooks. *Journal of Literacy Research*, 34(3), 357-384.
- Duke, N. K., Pressley, M., & Hilden, K. (2006). Difficulties with reading comprehension. In C. A. Stone, E. R. Silliman, B. J. Ehren, & K. Apel (Eds.), *Handbook of language and literacy: Development and disorders* (pp. 501-520). New York: The Guilford Press.
- Freire, P. (1997). *Pedagogy of the oppressed* (30<sup>th</sup> anniversary ed.). (Ramos, M.B., Trans.). New York: Continuum Publishing Company.
- Gee, J. (2001). Reading as situated language: A sociocognitive perspective. *Journal of Adolescent and Adult Literacy* 44 (8), 714-725.
- Gee, J. P (2007) *Social linguistics and literacies: Ideology In discourses* (3<sup>rd</sup> ed.). New York: Routledge.
- Gee, J. P. (2008). Being a lion and being a soldier: Learning and games. In Coiro, J., Knobel, M., Lankshear, C., Leu, D. J. (Eds.), *Handbook of Research on New Literacies* (pp. 1023-1036). New York: Taylor and Francis.
- Gee, J. P., & Hayes, E. R. (2011). *Language and learning in the digital age*. New York: Taylor & Francis.
- Government of Alberta. (2009). *Living literacy: A literacy framework for Alberta's next generation economy*. Alberta Advanced Education and Technology. Retrieved from <http://act.alberta.ca/community.aspx>.
- Graesser, A. C., McNamara, D.S., & Louwerse, M. M. (2003). What do readers need to learn in order to process coherence relations in narrative and expository text? In A.P. Sweet & C.E. Snow (Eds.), *Rethinking reading comprehension* (pp. 82-98). New York: The Guildford Press.
- Grisham, D. L. (2000): Connecting theoretical conceptions of reading to practice: A longitudinal study of elementary school teachers. *Reading Psychology*, 21(2), 145-170.
- Grossman, P. L., Valencia, S. W., Evans, K., Thompson, C., Martin, S., & Place, N. (2000). Transitions into teaching: Learning to teach writing in teacher education and beyond. *Journal of Literacy Research*, 32(4) 631-662.
- Hammerness, K. Darling-Hammond, L. Grossman, P. Rust, F. & Schulman, L. (2005). How teachers learn and develop. In Darling-Hammond, L & Bransford, J. (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do*. (pp. 358- 389). San Francisco, CA: The Guilford Press.
- Hatano, G. & Inagaki, K. (1986). Two courses of expertise. In H. Stevenson, H. Azuma, and K. Hakuta (Eds.), *Child development and education in Japan* (pp. 262-272). New York: Freeman.
- Heller, R., & Greenleaf, C. L. (2007). *Literacy instruction in the content areas: Getting to the core of middle and high school improvement*. Washington, DC: Alliance for Excellent Education.
- Hoffman, J. V., Roller, C., Maloch, B., Sailors, M., Duffy, G., Beretvas, S. N., & National Commission on Excellence in Elementary Teacher Preparation for Reading Instruction. (2005). Teachers' preparation to teach reading and their experiences and practices in the first three years of teaching. *The Elementary School Journal*, 105(3), 267-287.

- Johnson, D. (2010). Teaching with authors' blogs: Connections, collaboration, creativity. *Journal of Adolescent and Adult Learning*, 39, 348-357.
- Jones, S., & Enriquez, G. (2009). Engaging the intellectual and the moral in critical literacy education: The four-year journeys of two teachers from teacher education to classroom practice. *Reading Research Quarterly*, 44(2), 145-168.
- Kalantzis M., & Cope, B. (2011). *Literacies*. New York: Cambridge University Press.
- Kane, S. (2011). *Literacy & Learning in the Content Areas* (3<sup>rd</sup> edition). Scottsdale, Arizona: Holcomb Hathaway, Publishers.
- Keyes, D., (2009). Narratives of critical literacy: Critical consciousness and curriculum-making at the middle level. *Critical Literacy: Theories and Practices*, 3(2), 42-55.
- Keyes, D. K. (2011). Making curriculum of lives living a story of critical literacy. In Kitchen, J., Parker, D.C., Pushor, D. (Eds.), *Narrative inquiries into curriculum making in teacher education* (pp. 239-260). Bingley, UK: Emerald Group Publishing Limited.
- Kim, H. S. & Kamil, M. L. (2003). Electronic and multimedia documents. In A.P. Sweet & C.E. Snow (Eds.), *Rethinking reading comprehension* (pp. 166-175). New York: The Guildford Press.
- Krashen, S. (2004). False claims about literacy development. *Educational Leadership*, 61 (6), 18-21.
- Lankshear, C. & Knobel, M. (2003). *New literacies: Changing knowledge and classroom learning*. Philadelphia: Open University Press.
- Lee, O., Penfield, R. D. & Buxton, C. A. (2011). Relationship between “form” and “content” in science writing among English language learners. *Teachers College Record*, 113 (7), 1401-1434.
- Lind, A. (2008). *Literacy for all: Making a difference*. Paris: United Nations Educational, Scientific and Cultural Organization International Institute for Educational Planning. Retrieved on July 25, 2012 from <http://www.unesco.org/new/en/education/themes/education-building-blocks/literacy/resources/key-publications/>
- Lortie, D. C. (1975). *Schoolteacher: A Sociological Study*. Chicago, Illinois: The University of Chicago Press.
- McKenna, M. C., & Robinson, R. D. (1990). Content literacy: A definition and implications. *Journal of Reading*, 34(3), 184-186.
- McKenna, M.C. & Robinson, R.D. (2014). *Teaching through text: Reading and writing in the content areas* (2<sup>nd</sup> ed.). Boston, MA: Pearson.
- Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco, CA: Jossey-Bass.
- Moje, E.B., Ciechanowski, K.M., Kramer, K., Carillo, R., & Collazo, T. (2004). Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly*, 39 (1), 38-70.
- Morocco, C. C., Aguilar, C. M., Bershad, C. J., Kotulam A. W., Hindin, A. (2008). *Supported literacy for adolescents: Transforming teaching and content learning for the 21<sup>st</sup> century*. San Francisco, CA: Jossey-Bass.
- New London Group (Cazden, C., Cope, B., Fairclough, N., Gee, J., Kalantzis, M., Kress, G. & Nakata, M.). (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review*, 66(1), 60-92.



- O'Brien, D. G. & Stewart, R. A. (1990) Preservice teachers' perspectives on why every teacher is not a teacher of reading: A qualitative analysis. *Journal of Reading Behavior*, 22(2), 101-129.
- Olson, C. (2011). *The reading/writing connection: Strategies for teaching and learning in the secondary classroom* (3<sup>rd</sup> ed.). Boston: Pearson.
- Robertson, L., & Hughes, J. M. (2011). Investigating pre-service teachers' understandings of critical media literacy. *Language and Literacy*, 13(2), 37-53.
- Ross, D. & Frey, N. (2009). Real-time teaching: Learners need purposeful and systematic instruction. *Journal of Adolescent and Adult Literacy*, 53(1), 75-78.
- Scharlach, T. D. (2008). These kids just aren't motivated to read: The influence of preservice teacher's belief on the expectations, instruction, and evaluation of struggling readers. *Literacy Research and Instruction*, 47(3) 158-173.
- Seixas, P., & Peck, C. (2004). Teaching historical thinking. In A. Sears & I. Wright (Eds.), *Challenges and Prospects for Canadian Social Studies* (pp. 109-117). Vancouver: Pacific Educational Press.
- Shanahan, T. & Shanahan, C. (2008). Teaching disciplinary literacy to adolescents: Rethinking content-area literacy. *Harvard Educational Review*, 78(1), 40-59. Retrieved October 10, 2012, from <http://search.proquest.com.libproxy.stfx.ca/docview/212267873/13A2C9AD8CF61AD45AE/5?accountid=13803>
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2). 4-14.
- Smagorinsky, P., Wilson, A. A., and Moore, C. (2011) Teaching grammar and writing: A beginning teachers dilemma. *English Education*, 43(3), 262-292.
- Sweet, A. P. & Snow, C. (2002). Reconceptualizing reading comprehension. In C.C. Block, L.B. Gambrell, & M. Pressley (Eds.), *Improving comprehension instruction: Rethinking research, theory, and classroom practice* (pp. 17-53). San Francisco, CA: Jossey-Bass.
- Taboada, A., Guthrie, J. T., & McRae, A. (2008). Building engaging classrooms. In R. Fink and S.J. Samuels (Eds.), *Inspiring success: Reading interest and motivation in an age of high-stakes testing*. Newark, DE: International Reading Association.
- United Nations Educational, Scientific and Cultural Organization (2008). *A review of concepts, methodology and current data*. Montreal: UNESCO Institute for Statistics.
- Vacca, R. T., & Alvermann, D. E. (1998). The crisis in adolescent literacy: Is it real or imagined? *NASSP Bulletin*, 82, 4-9.
- Williams, C. H. (2006). "You gotta reach 'em": An African American teacher's multiple literacies approach. *Theory into Practice*, 45(4), 346-351.

#### *Author Biographies*

**Anne Murray Orr** is an Associate Professor in the Faculty of Education at St. Francis Xavier University in Nova Scotia. Her current research is in the areas of early literacy, content area literacy, Indigenous language immersion programs, and pre- and in-service teacher education.

**Jennifer Mitton Kukner** is an Assistant Professor of Assessment, Literacy, and Qualitative Research Methods in the Faculty of Education at St. Francis Xavier University in Nova Scotia. Her research areas include content area literacy, pre- and in-service teacher education, and teachers as researchers.

**D. J. Timmons** is a Grade 7 teacher in the Kativik School Board in northern Quebec. His research interests include critical literacy, the history of Japanese Canadian internment and deportation during World War II, and other issues of citizenship, human rights, and social justice.

*Appendix A: Interview Guide for participants Spring 2012*

1. Tell me about your initial thoughts when you learned you would be taking a course in *Literacy in the Content Areas*.
2. What were your impressions/feelings during the first few weeks of the course?
3. What were some of the significant moments in the course? What stood out for you?
4. Was there a turning point for you, when you realized you could use these literacy strategies in teaching your science, math, or social studies courses? If so, describe that turning point.
5. What literacy strategies can you remember from the course that will be useful to you in your teaching?
6. Did you try any of the literacy strategies in your teaching placement? If so, which ones? How successful were you at implementing them? Why do you think that? If you did not use any of the literacy strategies, what are the reasons for this?
7. Across Canada, provincial departments of education and school boards are placing an increasing emphasis on the understanding that *all* teachers are teachers of literacy. How do you feel about having this responsibility?
8. How will you take up this responsibility? What literacy strategies do you see yourself using in the science, math or social studies courses you will teach?
9. Suppose you get a full-time job as a math, science, or social studies teacher. What are the literacy goals you will have in that position?
10. There is pressure on all science, math or social studies teachers to raise achievement levels. What place do literacy strategies have in school goals to increase these achievement levels?