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Inquiring into Pre-service Content Area Teachers' Development of Literacy Practices and Pedagogical Content Knowledge

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Abstract: The focus of this qualitative multi-year case study is on pre-service teachers' experiences related to the development of their literacy practices in teaching high school science, math, social studies and other content area courses during their final field placement in a teacher education program. Results indicate tangible indicators of overall growth in participants' developing pedagogical content knowledge as well differences in the depth of their learning. All participants willingly supported the idea of integrating literacy in content area courses, but their successes were somewhat uneven, and reflective of their evolving pedagogical content knowledge, as they attempted to make literacy practices a regular part of their teaching practices. Our findings should be of interest to teacher education programs and school districts in supporting pre-service and beginning teachers as they develop their practices as teachers of literacy in content areas.

Introduction

With the increased use of standardized assessments to measure students' literacy proficiency, such as the Program for International Assessment (PISA), teacher accountability for student literacy achievement in all subject areas is brought sharply into focus (Cheng, Klinger, & Zheng, 2009). In Canada it was reported that students across the four Atlantic Canadian Provinces "performed below the Canadian average for both the combined reading and reading sub-scales" (Knighton, Brochu, & Gluszynski, 2010, p.17) of the 2009 results of the PISA, indicating that reading and other literacy skills are relevant concerns for Atlantic Canadian schools. Regardless of how much significance one attributes to these assessments, it is certain that 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. Pre-service teachers require a strong foundation in this area as they prepare to teach students in schools throughout Canada and beyond.

This is the third year of a multi-year longitudinal study of pre-service and beginning content area teachers' literacy practices and how these practices change over time. We began this study partly in response to local and national contexts of concerns with math and literacy results on standardized achievement tests described above, and the impact of such tests on teacher education in Canada. At the same time, we observed pre-service teachers' (PSTs') positive responses to a course we teach called *Literacy in the Content Areas* in the Bachelor of Education (B Ed) program at our small Canadian university. The course aims to improve content area

teaching through attention to literacy and through deeper understanding of language processes in learning. It covers explicit teaching of literacy skills (comprehension, vocabulary, fluency, writing); the role and use of informational texts; appraisal of student abilities in print and non-print language modes; and strategies to support and extend learning through literacy.

We wanted to learn more about whether and how PSTs were beginning to integrate literacy into their secondary content area courses. The research questions we investigate are: After completing a course in content area literacy strategies, are PSTs integrating new literacy strategies during their field experience? If so, how do they enact the use of these strategies in their teaching? Does the use of content area literacy strategies inform improvements in their teaching practices during field experience? Were there any negative outcomes from their attempts to use content area literacy strategies in their teaching? How do new teachers refine their use of literacy practices in their first years of teaching? In this paper we explain how we have begun to conceptualize PSTs' developing pedagogical content knowledge (Shulman, 1986) as represented in their responses to interview questions about the *Literacy in the Content Areas* course and about their experiences using what they learned as part of their content area teaching practices during their final field placement.

Content Area Literacy and Pre-service Teacher Education: A Myriad of Possibilities

Our review of the literature on content area literacy suggests that research has primarily focused upon pre-service teachers' responses to coursework (Daisey, 2009, 2012; Estrada & Grady, 2011) and, to a lesser degree, how PSTs have integrated literacy methods into their teaching practices during field experiences and into their first years of teaching (Alger, 2009; Barry, 2002). Much of this research is situated in the United States and little is known about the literacy knowledge and practices of content area pre-service teachers in Canadian teacher education programs¹ with the exception of studies conducted by Bergoray (2002, 2008).

While this body of work has empirically established that content area literacy courses are critical in broadening PSTs' understanding of literacy (Alvermann, Rezak, Mallozzi, Boatright, & Jackson, 2011; Bergoray, 2002; Estrada & Grady, 2011; Freedman & Carver, 2007), it has also shown that PSTs' responses to the concept of literacy as part of their instructional practices are widely varied and are deeply connected to course work (Barry, 2012; Daisey, 2009; Estrada & Grady, 2011; Lesley, 2014), the opportunity to try out literacy strategies as part of their field experiences (Daisey, 2012), the contextual constraints of field experiences (Bean, 1997; Grossman et al., 2000; Robertson & Hughes, 2011), the mixed messages they receive from teacher educators and cooperating teachers (Alvermann et al., 2011), and the school contexts of their early teaching years (Caudle & Moran, 2012; Hoffman et al., 2005).

Enriching and complicating the larger picture of what is known about pre-service teacher education and content area literacy is research that demonstrates the multiple challenges connected to the education of PSTs and their attitudes towards literacy in general, and to infusing literacy into their instructional practices. Studies have shown that PSTs' conceptions of literacy are shaped by inflexible attitudes towards literacy (Bean, 1997; Draper, 2002), a lack of belief in capability and responsibility for teaching students to read (Mallette, Readence, McKinney, & Smith, 2000; Nierstheimer, Hopkins, & Schmitt, 1996; Scharlach, 2008), limited use and understanding of metacognitive strategies as part of their own reading practices (Lesley, Watson, & Elliot, 2007), and prior school experiences informing PSTs' identities and expectations for

literacy in content area classrooms with an inclination to replicate traditional models of learning (Lesley, 2011).

Recent strides in the field have included scholars advocating for a disciplinary literacy focus (Shanahan & Shanahan, 2008) underlying content area literacy courses (Hillman, 2014; Fang, 2014). Scholars have found possibilities for content area literacy instruction situated in interdisciplinary pre-service teacher education classrooms; these sites may be seen variously as opportunities for PSTs to inquire into content area literacy pedagogy (Lesley & Matthews, 2009), to examine and disrupt prior literacy assumptions (Daisey, 2012; Estrada & Grady, 2011; Lesley, 2011; Nourie & Lenski, 1998; Stevens, 2002), and to explore the role of new literacies such as critical, digital, visual, performative, and alternative texts in content area instruction (Alger, 2007; Alvermann & Heron, 2001; Barry, 2012; Guzzetti, Elliott, & Welsch, 2010; Robertson & Hughes, 2011; Sheridan-Thomas, 2006). In short, there is little consensus about the best practices for preparing pre-service content area teachers to make literacy a part of their teaching practices and teacher educators are faced with a myriad of possibilities when shaping their courses (Lesley, 2014).

As part of our research into secondary PSTs' efforts to infuse their content area teaching with literacy practices, we are mindful about what is known about pre-service teacher education and content area literacy instruction. We situate our research using the concept of pedagogical content knowledge (PCK) (Shulman, 1986), as we study whether PSTs integrate literacy into their content area classrooms and, if so, how they navigate related challenges. We are attentive to the possibility that PSTs may not have used what they learned in the content area literacy course due to the possibility that they may have forgotten or rejected course content. Additionally, we also look for evidence of PSTs' inept application of practices learned in the content area literacy course in order to consider how their learning in literacy-related education courses may have failed to translate into effective classroom practices. This study provides insights into how to improve content area literacy courses in teacher education programs. As well, it suggests how pre-service and new teachers' PCK develops through field experience, and as our study continues, into the first two years of teaching.

Pedagogical Content Knowledge and Literacy in the Content Areas

A number of conceptual frameworks have been developed to aid understanding of pre-service teachers' pedagogical content knowledge (PCK) (Shulman (1986) in specific subject areas (Fang, 2014; Hill, Ball, & Schilling, 2008; Hillman, 2014; Leslie, 2014). This paper focuses on how PSTs' infusion of literacy into their content area courses reflects their developing PCK as they seek to become "adaptive experts"² (Hatano & Inagaki, 1986) in their profession. Shulman describes pedagogical content knowledge as one of three kinds of knowledge teachers possess, alongside content knowledge and curriculum knowledge. Shulman explained PCK as an awareness of those forms of representation that are most relevant for the teaching and learning of topics in a subject area, an understanding we perceive as integral to literacy in one's content area. After the first year of our longitudinal inquiry, we (Murray Orr, Mitton-Kukner, & Timmons, 2014) noted that,

Shulman's (1986) 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. (p. 5)

In that paper we described how our interviews with PSTs demonstrated that participants were at different stages in the development of their PCK. While this was a process we imagined continuing over the course of their careers, for those who showed a willingness to consider literacy strategies as part of their instructional practices, we also noted there were others who showed early signs of becoming practitioners unwilling or unable to engage with relevant literacy strategies in the teaching of their disciplines. Here, as we represent findings from the second year of our study, we illustrate how we are beginning to conceptualize organic growth in PCK as a way to understand some PSTs' increasing facility in infusing their teaching with literacy strategies. We observed these participants at various stages of growth in PCK. We noted the impact that the context of the field placement appears to have on PSTs' literacy practices, and began to tease out other factors that affect those practices, all the while with an awareness that each teacher's stance and practices will change, probably rapidly, over the first few years of their careers.

Our Methodological Approach to Learning from Pre-Service Teachers and their Use of Literacy Strategies in their Content Area Teaching

This study responds to the repeated call for longitudinal investigations of how teachers grow and change as they move from pre-service programs to their first years of teaching (Alger, 2007; Bean, 1997; Cochran-Smith et al., 2012; Caudle & Moran 2012; Grisham, 2000; Grossman et al., 2000; Hoffman et al., 2005; Jones & Enriquez, 2009). Lesley (2014) notes, "Additional research is also needed that examines the extent to which teacher candidates successfully implement content area literacy methods as first year teachers" (p. 60). We endeavor to approach our work from the perspective of Cochran-Smith (2013) and her suggestion that "we need researchers who can get at the nuances of the work of teaching and learning" (p. xi), because "teaching [is] unforgivingly complex, not simply good or bad, right or wrong" (p. x). We strive to understand more about the "multiple realities" (Creswell, 2007, p. 16) of pre-service and new content area teachers' experiences as they develop their literacy practices. Through our inquiry, the experiences and voices of individuals provide vital insight into how these teachers "interpret their experiences" (Merriam, 2009, p. 5).

Picking up on Lesley's (2014) suggestion, we are conducting a multi-year case study of the evolving literacy practices of teachers of math, science, social studies, and specialties including physical education, art, family studies, and music. We have found few other studies that follow teachers through these early career years as they develop content area literacy teaching methods in their subject areas (Begoray, 2002, 2008). A multi-year qualitative case study may be defined as an investigation of multiple bounded systems, drawing on data collected using a number of sources, and analyzed descriptively for case-based themes (Creswell, 2007; Merriam, 2009; Stake, 2006). In this study, we see the case as tightly focused on the evolution of literacy practices of pre-service teachers and graduates of one teacher education program in Atlantic Canada as they begin their teaching careers: a small number of participants and a small teacher education program research site. This paper reports on our findings regarding pre-service teachers in the second year of the study, 2013.

Data Collection Methods in our Multi-Year Study

In the spring of the first year of the study, 2012, we interviewed six new teachers who had just graduated from the B Ed program, and whom we had taught in the *Literacy in the Content Areas* course. We inquired into whether their PCK regarding literacies was expressed in their descriptions of their experiences during practicum (Murray Orr et al., 2014). In the spring of 2013, we conducted the second data-gathering phase of our longitudinal study, interviewing 16 PSTs whom we had taught in the *Literacy in the Content Areas* course in the winter of 2013 (See interview guide in Appendix A), and observing nine of them for one lesson during their spring practicum. The participants were all secondary PSTs, who were certified by the province to teach mathematics, science, social studies, or other content area subjects, after their completion of the final practicum in May 2013. It is the interview data from 2013, the second year of the study that is the focus of this paper. As in 2012, the course we taught was completed and grades were submitted before we interviewed participants, and we did not supervise these students during their practicum. Therefore the relationships we had with the participants at this point did not involve supervisory capacity over the participants with regards to evaluation.

We invited 16 participants to talk with us about their learning in the course and their attempts to integrate literacy into their content area teaching practices during their final six-week field experience in March and April 2013. These interviews took place in April 2013; some were face-to-face and others were by phone or Skype. The interviews were semi-structured, approximately 30 minutes in length, and were transcribed by a research assistant. We also asked participants if we could attend one of the lessons they taught during their field experience in April 2013, to observe how they incorporated literacy into their teaching. Out of 16 participants, nine granted us permission to visit their classrooms and observe their teaching. The first author, Mitton-Kukner, visited five PSTs' classrooms while the second author, Murray Orr, visited four, and each of us took field notes as we observed. In this paper we focus upon the interviews conducted with all 16 PSTs³.

Data Analysis and Representation Methods

During data analysis we analyzed the interview transcripts along with our field notes from the interviews and the observations. The process of data analysis involved inductively analyzing as we read and re-read the data (Creswell, 2007; Merriam, 2009). Each author noted themes she saw emerging across interview transcripts and field notes. There were approximately ten potential themes identified. After discussing these themes we found some did not have enough data to support their inclusion in our findings. As we returned to the data we determined there were six themes for which evidence recurred repeatedly, three themes related to apparent characteristics of PSTs, who seemed strongly committed to infusing their teaching with literacy practices (eight of 16 participants) and three characteristics associated with PSTs who appeared uncertain about the role of literacy practices in their content area teaching (five of 16 participants). Some PSTs (three of 16 participants) expressed ideas that seemed to fit within both categories, illustrating the complexities of studying the development of PSTs. The three themes associated with the PSTs who were strongly committed to literacy infusion were: expanded understandings of literacies, literacy routines as opportunities for thinking and learning, and clear connections to curriculum outcomes and relevant authentic assessments. The three themes connected to PSTs who were less certain about the role of literacy in their teaching were:

inability to speak fluently about the ways literacy might be incorporated into teaching, lack of metacognitive awareness of how to plan to infuse literacy strategies, and lack of awareness about the need to model and practice literacy strategies. In the following section we describe the main themes and include excerpts from interview transcripts relevant to each theme. In the discussion section we connect these findings to the developing PCK of these new teachers.

Findings: Differences Among Pre-service Teachers' Infusion of Literacy Strategies into their Content Area Teaching

As we analyzed the data from 2013, we realized that how participants talked about their use of literacy strategies in their content area classrooms provided windows into how each one conceptualized the infusion of literacy into her or his practice as a content area teacher. Although all PSTs' responses during interviews showed greater awareness of how they might incorporate literacy into their teaching than they had before taking the *Literacy in the Content Areas* course, we note that some PSTs provided examples where we perceived misalignment between the reported purpose of the activity and the literacy strategy that was chosen to facilitate student learning. The findings section is divided into two subsections; the first provides our interpretation of some PSTs' highly articulate descriptions of their teaching practices (eight of 16 participants: Brenda, Don, Elizabeth, Mary, Byron, Kelly, Andrea, Linda⁴), which appear to reflect their commitment to infusing their content area classrooms with literacy strategies. In the second subsection we represent our analysis of other PSTs' responses to interview questions (five of 16 participants: Bill, Nell, Candace, Cassie, Sam), which suggest they are not purposefully and skillfully infusing their content area teaching with literacy practices. As described earlier, three PSTs, specifically Nancy, Lana, and Sandra, described ideas that fit within both categories. In what follows findings are clustered together according to theme and represent a sample of the frequency found across the PSTs' descriptions of their understanding and use of literacy strategies in their content area teaching.

Characteristics of Pre-Service Teachers with Clear Goals of Infusion of Literacy Practices into their Content Area Teaching

Our analysis of the comments of PSTs who clearly articulated how and why they infused their teaching in content areas with literacy practices revealed strengths in three areas: expanded understandings of how literacies are integral to their content areas; regular use of literacy strategies as opportunities for high school students to deepen their thinking and learning about topics in the content area classroom; and clear connections to curriculum outcomes along with appropriate assessment plans.

Expanded Understandings of Literacies

For secondary content area PSTs, using the language of literacies, thinking about their subject areas and the lessons they taught in terms of literacies was a new and different perspective. Andrea, a PST, described her realization that she had actually been using literacy strategies in her mathematics classes but was not aware of it.

Like, I'm supposed to teach them math, but now [after taking the *Literacy in the Content Areas* course] that I understand more what content literacy is, I see that it's really something I have been doing in the past...it's kind of already built into the way that I teach and the conversations I like to get going with students...getting them to write about their understanding, and not just work on equations and kind of introducing the multiple representations that we talk about a lot in math. (Pre-service math and science teacher Andrea, Interview May 2, 2013)

Andrea saw her earlier field experiences in math classes in a different light after taking the *Literacy in the Content Areas* course in the final term of her B Ed. This seems to suggest that her definition of literacy became broader and more inclusive, helping her see more expansive literacy possibilities in her math classes. Elizabeth, another PST, appeared to see literacy differently after taking the course too.

You know, [I used to think]... if the writing isn't correct and the spelling isn't correct and grammatically it just doesn't make sense [there was little learning]. But now, I think, I have a better understanding of the idea of getting ideas on paper and making the connections between our thoughts and being able to write things down or draw things or express your ideas. I see that more as having a valid purpose in the classroom...(Pre-service physical education and science teacher Elizabeth, Interview April 29, 2013)

Elizabeth recalled that her initial ideas about literacy were confined to conventions of spelling and grammar. She described how she grew to understand that literacy can be about "connection[s] between our thoughts" and the expression of ideas. She stated that literacy has "a valid purpose" in her classroom, beyond matters of correctness. These participants' words reflect a growing ability to see literacies as not only relevant but essential to each subject area.

Literacy Routines: Literacy is about Opportunities for Thinking and Learning

PSTs who identified the ongoing use of literacy strategies as a part of their teaching during field experience spoke of a relationship between deeper learning and regular infusion of literacy activities as routines in their classrooms. Those who identified literacy strategies as creating opportunities for deeper learning also demonstrated a willingness to spend time in the classroom investing in the processes of literacy. For example, in the following excerpt, a pre-service mathematics and science teacher, Byron, described his rationale for allowing students class time to work on a newspaper writing activity on the topic of universal gravitation research as part of a grade 12 physics unit.

I was just going to do a regular kind of research project that might have been like a one-day thing, but the two days, I think, was better because it connected it to something a little more real. [In] that unit there wasn't a lab component to that chapter, so it was nice to do something a little more hands-on or thinking outside the calculation and content base of the chapter...I gave them two days in class to do it...Some of them were a little farther along than the other[s]. When they got to a certain point they moved onto some other stuff, but...for the most part about 90% of the class, everybody was engaged so I thought it was really good. (Pre-service math and science teacher Byron, Interview April 24, 2013)

During this series of lessons, students were introduced to a newspaper front-page strategy in connection to four curriculum outcomes from grade 12 physics. The outcomes that were addressed through this strategy targeted student understanding of (1) scientific and technology issues as applied to orbital situations; (2) circular motion through Newton's laws; (3) Newton's Laws of Universal Gravitation and Kepler's three laws of planetary bodies; (4) societal issues (sustainability, environment, political, and historical perspectives) in relation to topic. In the first lesson, student received a detailed project outline that explained a step-by-step plan of how they were to complete the project in order to demonstrate their knowledge of targeted curriculum outcomes. Byron also had students consider various audiences for whom they might design their front page and provided examples of different types of newspaper front pages (Murray Orr field notes, April 15, 2013).

During the interview with Murray Orr, Byron talked about choosing to have his students use a literacy-based activity, the newspaper front page, to demonstrate their knowledge in relation to the four physics outcomes. Because one of the outcomes dealt with societal issues in relation to the topic of universal gravitation research, Bryon felt this choice was especially appropriate. Students could focus on topics like whether humans can thrive in decreased gravitational settings like spaceflight, over the long term. He highlighted the suitability of the topic to the literacy strategy, as "there wasn't a lab component to that chapter" and it was an opportunity "to do something a little more hands-on or thinking outside the calculation and content base of the chapter." Byron emphasized that because time was created for students to work on this in the classroom, it enabled them to "connect to something a little more real." Influencing his decision about creating opportunities for students to work on this task in the classroom was his acknowledgement that some students "had trouble connecting" with the writing genre as they were more familiar with the writing of a "scientific paper...but to talk about like an actual issue or idea...[in] newspaper style writing. A lot of them had trouble with that" (Pre-service math and science teacher Byron, Interview April 24, 2013). Byron went on to explain that in order for the students to get the most out of the activity, he had to support students to approach learning in this new way in physics and provide them with prompts and timely feedback. He emphasized, "most of it's just scaffolding the activity itself," as the use of literacy strategies needs to be purposeful and made explicit to students (Pre-service math and science teacher Byron, Interview April 24, 2013). Murray Orr, in her observation of Byron's class, noted that as Byron introduced this activity to students following the discussion of project outline, he engaged students in a pre-writing activity in which they worked in pairs or groups of three to complete a graphic organizer that encouraged them to brainstorm relevant topics for their newspapers. Following this opening activity, Byron had students move to the library to begin purposeful research on identified topics. This would lead to a draft of the newspaper front page, which would later be revised and edited (Murray Orr field notes, April 15, 2013).

Similarly, another pre-service science and art teacher, Linda, emphasized the importance of continuity for students when using literacy strategies.

One thing is to make it a routine. Because when you just randomly throw writing assignments at students they're either overwhelmed or they don't take it seriously. So as a pre-service teacher coming in, they [high school students] weren't used to this at all in my art room...if I was an art teacher, I would start that in the very beginning of each assignment and also tell them [the students], like "think about as you're making this, what's challenging" plant

the seed so that later they can write about it. (Pre-service science and art teacher Linda, April 24, 2013)

This PST, like many of the participants, noted the importance of supporting students when implementing literacy strategies that needed scaffolding, such as larger writing assignments. She also emphasized the challenge of establishing literacy routines in her practicum classroom, while identifying what she would like to do in the future once she was established in a school. Another mathematics and science PST, Andrea, also identified continuity as important and described how she used concept mapping as a regular part of her grade 10 math classroom.

So, just an example, we did some concept maps and things like that. There was one section that we did that involved a lot of different things...A lot of different pieces, I guess, to what we were doing. So, after we would finish each piece [we would] try to add that piece into our concept map and talk about the connections...that we'd already talked about...that sort of thing helped them...[to] organize their ideas and they could also use it as a tool to study for the quizzes, their tests, or their exam at the end of the year...they'd have all the information in one spot. (Pre-service math and science teacher Andrea, May 2, 2013)

In this example, we note Andrea's infusion of literacy into the teaching of math in ways that she pragmatically saw as useful for her students (test preparation) and in ways that enabled students to make deeper connections over time and between topics. PSTs also talked about how the frequent use of literacy strategies encouraged student engagement, which they felt led to deeper learning. Sandra, a social studies and physical education PST, explained that her inclusion of literacy strategies was connected to her "willingness to not let the kids get bored...I incorporate[d] a lot of different literacy strategies, a lot of different ways of learning,...so that students were constantly engaged" (Pre-service social studies and physical education teacher Sandra, July 31, 2013).

Some of the participants who saw the regular infusion of literacy as creating opportunities for deeper learning also articulated the ways literacy routines potentially encouraged students to understand concepts from the perspective of that discipline. In the following excerpt, Andrea described the importance of establishing this approach to learning in the classroom and contrasted her literacy goals with her recent practicum experiences as a way of emphasizing this.

That would be a major goal, because right now it seems like when I try these things with students [literacy strategies]...that's not really what's been valued in the past so it's harder for them [high school students] to kind of except it. So that's something I would work towards, using more...performance assessments...where they're required to...have conversations or write about their understanding. It's not just solving equations all the time, which is what typically happens. So I think my goal would be to kind of get students thinking like mathematicians and writing like mathematicians and to see...that there is value in doing that, and it will help develop a better understanding of the concepts that we're doing. (Pre-service mathematics and science teacher Andrea, May 2, 2013)

As well as articulating her goal of developing literacy routines in her classroom Andrea's comments illustrate her awareness of distinctive features of literacy in mathematics, and how "thinking like mathematicians and writing like mathematicians" can lead to deeper learning for students.

Clear Connections to Curriculum Outcomes and Relevant Authentic Assessments

PSTs who were able to make explicit connections between curriculum outcomes, assessment, and literacy strategies appeared to be more likely to integrate those literacy strategies into their teaching. In an earlier example, Andrea spoke about an overarching curriculum goal, being able to understand concepts and communicate in math in different ways, visually and orally, in writing, and using symbols. Andrea was clear that literacy is about thinking and learning in one's subject area, in order to better understand the concepts that are integral to curriculum outcomes. Don, a music and social studies PST, described how he integrated writing breaks into instrumental musical performance, and how this connected with curriculum outcomes in music.

...we would do a group performance and then we would stop and then I would have each student comment on either their role or something they noticed or the general performance and then we would play it again and see "ok how did that improve? Ok what other changes would you make now?" and then after we've done that a few times, ok [pause], put your instruments away. We're going to write about it, so now you tell me how this could have been improved, how did we improve, what was a challenge you personally had while we were performing this piece, and how did you work to overcome this challenge? So with questions like that, it helped to have the students do writing, but it also fits directly in the outcomes, having students learn to use musical vocabulary to explain a piece, how to critically analyze music and personal reflection on how music impacts you and how it makes you feel. Like these are all in the curriculum! (Pre-service social studies and music teacher Don, Interview April 29, 2013)

Don's knowledge of the music curriculum enabled him to see how building in discussion and writing breaks during performance addressed outcomes, deepening students' critical thinking about their music using literacy tools.

In physical education, Elizabeth connected her familiarity with curriculum outcomes to assessment, and noted that literacy strategies helped her assess students' prior knowledge and skills.

Yeah, well in phys. ed. I noticed that these strategies were kind of helpful in terms of assessment, and getting baseline ideas of how, what students' understandings are of the physical skills that we're going to be doing or the sports that we might be playing. And then I also found that it was really helpful in terms of getting information on the outcomes (Pre-service physical education and science teacher Elizabeth, Interview April 29, 2013).

Elizabeth used exit slips and other short writing activities to "get...baseline ideas" about what knowledge and skills students were bringing into the lesson, to assess their understanding in terms of curriculum outcomes as she began to teach a new concept. Conversely, Kelly, a mathematics and science pre-service teacher, described using a carousel brainstorming activity in her Grade 10 math class to offer a different way to address a curriculum outcome related to measurement and graphing she had already taught.

They had already done work that was assessed on the outcome and I kind of, I just wanted them to look at the outcome in a different way. It was more kind of review for them [to] make sure they actually did understand. (Pre-service mathematics and science teacher Kelly, Interview April 24, 2013)

Elizabeth and Kelly provide examples of participants who understood how to effectively plan the use of literacy strategies according to the purpose of the lesson within a unit of study. These pre-service teachers were able to articulate the ways literacy strategies helped them address curriculum outcomes and assess student learning in their teaching. This clarity may have led to more confidence in infusing literacy into the routines of the classroom.

Characteristics of Pre-service Teachers who Articulated Interest but Uncertainty toward Infusion of Literacy into their Content Area Teaching

We noticed several tendencies in interviews with pre-service teachers who appeared to view literacy as an add-on, not an integral part of their teaching in high school content area courses: difficulty describing how literacy could be part of their teaching practice, a lack of awareness of how to plan to infuse literacy strategies, and little evidence of an attentiveness to the need to model and practice literacy strategies.

Inability to Speak Fluently About the Ways Literacy Might be Incorporated into Teaching

One of the tendencies we observed was a lesser ability to speak fluently about how literacy could be incorporated into the subject(s) the PST was teaching, or how outcomes might be addressed through literacy strategies. This stood in contrast to the interviews with pre-service teachers who appeared to be successfully infusing their practice with literacy strategies. For example in the following transcript excerpt, Bill, a mathematics and science pre-service teacher, talked about the use of graphs in his grade 10 data measurement unit.

Yeah, well I guess...with math 10, well math 10 academic and advanced...academic and foundations, we did data management, so we did a fair bit with graphs, so like we did histograms, stem and leaf plot, and box and whisker, and that kind of, we did some, we got some visual, different ways to represent our stuff, our knowledge, their findings and we also did activities where they gather data in the classroom... So I mean, there is probably some kind of something in there you could probably pull out related to literacy and different literary tools. (Pre-service math and science teacher Bill, Interview April 23, 2013)

In spite of the concrete example Bill provided, he could only say that there was “probably some kind of something...related to literacy” in the activity. Similarly, Candace, a family studies and science pre-service teacher in an alternate placement in an adult learning center, talked about teaching a series of science lessons about the digestive system in which she had students do a hands-on experiment. Interestingly, she did not consider connections to literacy.

I had two classes of science...one day...we went through kind of the entire GI tract, and then we had another day where we did a digestion lab...So we manually digested crackers in plastic bags that were in the stomach and then we ran them through pantyhose because that was the intestine. (Pre-service family studies and science teacher Candace, Interview April 30, 2013)

This activity was no doubt a vivid learning experience. It was one for which a literacy strategy such as drawing the process or creating a flow chart, could easily have been a relevant way for students to make meaning. Because literacy

did not seem to be infused in her teaching, Candace did not appear to think about extending the learning in this way. These examples contrast vividly with the articulate responses of some of the other pre-service teachers interviewed.

Lack of Metacognitive Awareness of How to Plan to Infuse Literacy Strategies

The ability to plan to infuse literacy strategies, to make them part of the routines of the classroom, was a strength observed in interviews with some PSTs. This was not the case with others, such as Bill, who seemed to view literacy strategies as fillers as seen in the following statement: “So I guess, I see a lot of the small little activities, you know, that ones that are easy you can kind of just throw in your lesson” (Pre-service math and science teacher Bill, Interview April 23, 2013). Candace, who was in an adult learning center placement, said she might have added some literacy strategies into her teaching but did not feel she could plan long-term with this goal in mind. “Yeah, I would say my daily lesson plans had an influence of writing and reading strategies within them, but long term planning is almost impossible.” (Pre-service family studies and science teacher Candace, Interview April 30, 2013). Candace seemed to struggle to articulate how literacy could be connected to her long term planning, despite working with adults for many of whom literacy was one of the greatest challenges. This surprising finding was echoed by Sam, a pre-service science and mathematics teacher, who completed a field placement in a high school learning center.

A lot of these students have really low-level comprehension levels. So a lot of the time I could not use, actually, I couldn't use a lot of the...techniques I learned in content area literacy... a lot of the students are used to a routine and it's a little bit difficult to change the way from it, or try to like move away from the routine. (Pre-service math and science teacher Sam, Interview April 23, 2013)

Sam found he had difficulty in planning to use the ideas he learned in the course for two reasons. He found the students' “comprehension levels” very low and seemed unable to imagine how the literacy strategies from his course could be applicable in this context. This is intriguing as ideas such as the incorporation of drawing and use of mind maps could work well for some struggling readers and writers. Sam had gone through the course with images of his previous high school science field placements in his mind. He wrote about the ways literacy could be integrated into his biology classes for example. However, he could not seem to adjust his thinking to the different reality of his new placement and connect literacy to this context. Secondly, he noted the students are “used to a routine” and he found it difficult to disrupt that routine. While this is a valid issue in a field placement, we acknowledge that the content area literacy course failed to influence Sam's teaching practices, particularly in how he described content area literacy strategies as better suited for students who do not struggle with literacy.

Nancy, another PST in a high school learning center placement, also talked about how hard it was for her to see how literacy strategies could be part of the planning for teaching and learning in that setting. She described how she would scribe for students, but noted, “Other than that it was, it was a task all in itself to kind of, just implement any type of strategy, let alone a reading and writing strategy for them” (Pre-service social studies teacher Nancy, Interview May 8, 2013). Three participants, Nancy, Sam, and Candace, all described their difficulties with imagining how to integrate literacy into learning centers, where young people and adults bring

significant challenges with literacy. This is important for us to note as instructors in the *Literacy in the Content Areas* course, as it appears that our approach thus far does not enable PSTs to see how to extend their thinking about literacy in their subject areas into settings in which students are working considerably below grade levels.

Lack of Awareness About the Need to Model and Practice Literacy Strategies

Some PSTs seemed to have a less developed sense of the importance of modeling and providing scaffolding when introducing literacy strategies with which students were unfamiliar, although this was a focus in the *Literacy in the Content Areas* course. For example, in the following Cassie explained a write-around she attempted with her Grade 11 social studies class.

I had given them a question and I can't remember exactly what the question was, but something about like, "why was this power shift significant and why would the Highlanders and the Jacobites have felt like what was happening in England was..." ... so I could get them into a discussion frame of mind. [However] it just did not go well at all. (Pre-service social studies teacher Cassie, Interview April 24, 2013)

When asked why she saw the write-around as unsuccessful, Cassie replied, Well part of me thinks...I didn't explain it very well, but...I explained it and then I asked if there were questions and so I was kind of re-explaining it and then you know, I was like, "All right are there any more questions?" and there weren't any more questions. But then a lot of the responses that I got on the actual sheet were, "I don't know what I'm actually supposed to be doing right now"...So I was kind of thinking maybe I didn't set it up that well? But then it also kind of makes me like wonder how [to set it up]. (Pre-service social studies teacher Cassie, Interview April 24, 2013)

Cassie's analysis of the lesson revealed her awareness that the students did not engage in the write-around as she had hoped, despite her explanation, and that "maybe [she] didn't set it up that well." However, Cassie did not articulate how she might do things differently the next time, nor did she seem to realize how to better scaffold the activity.

Some of the PSTs saw the inclusion of literacy strategies as potentially problematic. Bill suggested that activities such as a carousel, where students might walk around, discuss, and make written comments/solve various problems at stations around the classroom, could be risky.

So sometimes it's the old worksheets, like with the math 10 class sometimes, I'll give them one just because they have to practice...and they'll be quiet and work away at it. Sometimes I'd give them something and...they're way too wound up. So a new activity like...the carousel or something like that could really, it could...work with the hyperactive class, or it [might] not work with that kind of class...I think the carousel could go awry in the Math 10 class perhaps. (Pre-service math and science teacher Bill, Interview April 23, 2013)

Bill was concerned with keeping the class quiet and calm, which is not unusual for a pre-service teacher. He did not seem to think about how the students' learning was affected by the kinds of activities he chose for his math classes. He also seemed unaware of the importance of modeling and practicing when engaging students in new kinds of activities.

Similarly, Cassie felt a lack of success with an activity could be attributed to the students themselves. For example, she reflected on a timeline activity she had students do in groups in a

50-minute Canadian history class and their struggles to complete the task. "...then I find that the majority of students don't know how to write and they don't know how to kind of manage their [time], I don't know if it's [because] they can't focus or something" (Pre-service social studies teacher Cassie, Interview April 24, 2013). Cassie appeared to consider the students' shortcomings as the source of the problem rather than those of the activity and how it was structured.

Differences in PSTs' Infusion of Literacy into Content Areas Reflect a Range of Growth in their PCK

In the previous sections we demonstrate the different ways content area PSTs conceptualized their ability to integrate literacy into their instructional practices during their final field experience after completing the course, *Literacy in the Content Areas*. We noted our awareness of the flaws of self-reporting in interviews in an earlier section but highlight it again here, as we are aware that the themes we outline in this paper are somewhat tentative given this limitation. Cochran-Smith (2013) reminded us of the complexity of teaching and learning, and the limited usefulness of dichotomies about "good" and "bad" teaching. With this perspective, we view PSTs' literacy-related teaching experiences as reflecting a range of successes and we acknowledge that the content area literacy course may have failed to affect the classroom practices for some PSTs, particularly for those who described the use of literacy strategies as time fillers, as unsuited for students who struggled with literacy, or for those PSTs who were uncertain about how to model and scaffold the implementation of literacy strategies. Using a PCK lens (Shulman, 1986) enabled us to better understand the range of PSTs' successes as they tried to make literacy an integrated part of their teaching and to note where PSTs struggled to do so. This also allowed us to consider the development of their PCK as shown in their response to our questions, their reported descriptions of their teaching practices, and our observations of their classrooms.

All of the participants were able to share examples of how they used literacy strategies as part of their teaching and their beliefs as to why they should do so. However, as described earlier, there was a wide range of understanding and practices amongst the PSTs, with some being able to clearly express how and why literacy enriched the opportunities for student learning in content areas and others who struggled to do so. PSTs' abilities to make these connections and actualize these into opportunities for student learning demonstrated what we believe are tangible indicators of PCK growth. For example, being able to articulate clear goals for the infusion of literacy in relation to the learning of curriculum outcomes, as Byron did in describing his rationale for the newspaper writing activity in his grade 12 physics class, suggests that these participants are showing developing content knowledge and "that there are a variety of ways of organizing [a] discipline" (Shulman, 1986, p. 9).

Some PSTs also showed awareness of how the use of literacy strategies as part of regular classroom routines created opportunities for students to achieve and show deeper learning over time. Andrea described using a concept map regularly in her math class to help students organize and make connections among ideas. Shulman (1986) described this as pedagogical knowledge in that a teacher is able to choose and develop "the most useful forms of representation of those 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). As part of PSTs’ developing pedagogical knowledge, we also noted evidence of expanded understanding of literacies, connections to their metacognitive awareness of their own learning, and the connections they made between this awareness and the students they taught. Linda discussed how she in her future classroom would purposefully build in literacy strategies to “plant the seed” for deeper learning in her art class. PSTs’ awareness of their own learning and the shifts they experienced in response to the content area literacy course suggest they have a better understanding of how to deepen learning for students through the inclusion of literacy strategies.

Lastly, this group of participants also described their understanding of curriculum outcomes and how the use of literacy strategies enabled them to create better learning opportunities for students, targeting the ongoing assessment of those outcomes. Don built writing breaks into his music class and explicitly tied these to outcomes around critical thinking in music. We propose that Shulman’s (1986) description of PCK is demonstrated in the ways that participants were able to identify appropriate literacy strategies in connection to curriculum outcomes and their assessment of students’ achievement of said outcomes. Overall, this group of PSTs seemed to understand how they might deepen student learning and were responsive to the usefulness of literacy strategies as part of their teaching.

A lesser inclination to infuse literacy strategies into lessons, coupled with fewer articulate descriptions of the role of literacy in teaching in content area classrooms, seemed to exemplify another group of participants. For example, Bill who described the variety of graphs his students used in a Grade 10 math unit on data management but did not see how this represented literacy, in this case visual literacy. These PSTs learned how to use a variety of literacy strategies and tools in the *Literacy in the Content Areas* course but did not seem to grasp why they might use these ideas, beyond the notion that they might be fun or might keep students busy, as Bill noted. Some PSTs did not appear to be aware of the course’s foundational theory that literacy is a tool for deeper learning about content area topics. All PSTs interviewed expanded their teaching strategies repertoires but it appeared not all expanded their understanding of the learning process. As Shulman (1986) noted, PCK involves a grasp of “ways of representing and formulating the subject that make it comprehensible to others” (p. 9). While some PSTs articulated a strong metacognitive awareness of how to use literacy strategies to make topics comprehensible to their students, not all PSTs were mindful of how literacy activities might lead to deeper learning for their students. These PSTs were at a different place in the growth of their PCK.

This lack of metacognitive awareness manifested itself in difficulties with planning to incorporate literacy strategies into one’s teaching, as Bill, Candace, Sam and Nancy described in interviews. Three of these four PSTs were in high school or adult learning center placements for their field experience, spaces in which literacy is crucial component. Because they appeared unable to imagine how one could plan to incorporate literacy into their teaching in these settings, we acknowledge a lack of transferability of learning from the content area literacy course to their field experience teaching. Part of Shulman’s (1986) description of PCK is “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).” The backgrounds of students in learning centers would require PSTs to have a strong ability to grasp what made “learning specific topics easy or difficult” for those students, in ways that might be quite different from the needs of other learners of the same age. PSTs need to be able to use their PCK to employ strategies “most likely to be fruitful in reorganizing the understanding of learners” (p. 9). This aspect of PCK appeared

very challenging for these PSTs, and we note the importance of addressing in our future teaching the infusion of literacy strategies as responsive to the needs of students situated in learning centers.

Not surprisingly, difficulties with planning to include literacy strategies correlated with a lesser understanding of the value of modeling and providing guided practice when introducing literacy strategies. Cassie's unsuccessful write-around activity is an example of this, and she concedes she was unsure how to "set it up". Shulman (1986) asked, "how does he or she [the teacher] employ content expertise to generate new explanations, representations, or clarifications?" (p. 8). While Shulman refers to the teacher's ability to create novel ways of representing concepts as part of his or her PCK, knowledge of the best ways to have students explain, represent or clarify their learning is relevant here too. PCK might include an awareness of which literacy strategy might best deepen students' learning as well as how to employ that strategy, which would include pedagogical knowledge of how to model and provide practice with the method of representation, such as the write-around. This appears to have been a third area of challenge for some PSTs.

Concluding Thoughts

Every PST we interviewed felt he or she learned how to incorporate literacy strategies in content area teaching, although not all indicated they understood why they would do so. We noted tangible indicators of growth in PCK, represented as the six themes in our findings. These indicators allowed us to discern differences in the depth of learning evident in PSTs' interview comments, and to see these differences as reflective of their evolving PCK. Those PSTs who were able to speak purposefully about infusing literacy strategies into their teaching in order to create learning opportunities and to assess learning, as well as those who spoke less fluently on these topics, helped us see how valuable the idea of literacy as thinking and learning in content areas is for PSTs. In the *Literacy in the Content Areas* course, we plan to find ways to make this concept more accessible to all PSTs. As part of our ongoing research, we hope to develop a model of PCK growth over time related to PSTs' understanding of purposeful infusion of literacy into their content area teaching.

Notes

¹ Education in Canada is a provincial responsibility and separate teacher certification standards exist across Canadian provinces and territories. Typically, graduates of Canadian teacher education programs have completed a bachelor of education degree or a bachelor degree with additional educational certification in order to meet certification standards (Centre on International Education Benchmarking, n.d.).

² Hatano and Inagaki (1986) describe two types of expertise: routine expertise and adaptive expertise. Routine expertise involves becoming skilled at mastering procedures and practices whereas adaptive expertise involves deep conceptual knowledge and comprehension, enabling the individual to create original solutions and procedures to situations emerging in dynamic contexts.

³A limitation of this study is its reliance on self-reporting through interview data. We recognize that there was the potential for unintended subjective influences in PSTs' descriptions of their teaching. That is, PSTs' accounts of their teaching may not reliably reflect the events in their classrooms. We acknowledge this as a shortcoming of the study.

⁴ Pseudonyms are used for all participants' names in this study.

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Appendix A

Interview Guide for Pre-Service Teachers April 2013

1. Are you using any of the literacy strategies in your teaching practicum? If so, which ones? How successful do you feel you are at implementing them? Why do you think that? If you are not using any literacy strategies, what are the reasons for this?
2. What kinds of literacy strategies are most useful in your teaching (if any)? Why?
3. How is your lesson planning (both daily and long-term) shaped by your knowledge of literacy strategies in math, science, and/or social studies?
4. How are your assessment practices shaped by your knowledge of literacy strategies in math, science, and/or social studies?
5. 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?
6. 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?
7. Suppose you get a full-time job in your math, science, or social studies teaching area. What are the literacy goals you will have in that position?
8. 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?