

A pedagogy of place: Promoting relational knowledge in science teacher education

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Introduction

As a science teacher educator involved in a new four-year Bachelor of Education program, I am interested in the possibilities of an alternative approach to teacher education based on principles of relational, place-based teacher education that prepares teacher candidates for the complex and ever-changing educational environment. I have taught within traditional “theory-to-practice” (Carlson, 1999) teacher education programs at other institutions and, like most other educators (Wideen, Meyer-Smith & Moon, 1998), face the challenge—and frustration—of trying to have an impact on the later teaching practice of our teacher candidates (Dillon & O'Connor, 2010), or to foster what Argyris & Schön (1974) call *double-loop* learning, vis-a-vis the powerful impact that practicum experiences have on teacher candidates and beginning teachers. One of the reasons for this lack of integration of theory and practice is that theoretical/campus-based courses and school-based teacher candidate teaching tend to be completely divided into different time periods, different staff, and different places (Clandinin, 1995; Wideen et al., 1998) and “as a consequence, our students quite appropriately divide their professional education into two unrelated parts as they are expected effectively to change discourses and cross culturally determined borders in order to learn” (Rosean & Florio-Ruane, 2008, p. 712). Such conclusions have prompted educators to investigate alternate approaches to teacher education that foster realistic experiences (Korthagen, 2001) among teacher candidates in order to help them move beyond these typical limitations in their development as teachers.

Most specifically within my particular field of science education, teacher candidates and novice teachers often do not feel well prepared to teach science to their students; in particular, many feel that they possess little content and conceptual knowledge in science because of a lack of exposure or negative school science experiences (Banilower et al., 2013; Fulp, 2002; Mantzicopoulos et al., 2008). Beginning teachers may also feel pressured to omit science from their instructional time due to an increasing, often mandated, emphasis on other program of studies (Griffith & Scharmann, 2008; Marx & Harris, 2006). Another major contributing factor could also lie in the attitudes toward science and the self-efficacy beliefs teacher candidates hold about their own personal ability to teach science (Eschach, 2003; Kirik, 2013; Riggs & Enoch, 1990).

Central to this research is the identification and potential of key features associated with deliberate place-based pedagogical interventions intended to better integrate theory and practice and also expose participants' assumptions and beliefs about their science learning through more effective

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practices. The design of our curriculum of place, housed within the four-year Bachelor of Education program at Mount Royal University (Calgary, Alberta, Canada) might be best characterized as a pedagogy that is responsive to local conditions and the cultural, social, economic and environmental traditions of the educational context (Cajete, 1999; Kincheloe, 2001; Wattchow & Brown, 2011). Focusing on theory and practice links, our program integrates science field studies and inquiry-based projects utilizing a place-based approach that puts considerable onus on ecological field studies and longitudinal environmental assessments. Through a social-constructivist lens, in-school seminars, integrated weekly within a 5-week practicum, each involving cohorts of 8-12 teacher candidates from three partner schools, are facilitated by teacher educators to develop a sense of community (Lave & Wenger, 1991; Wenger, 1998) and support teacher candidates to reflect upon their teaching and develop responsive educational practices and adaptive expertise (Beck & Kosnik, 2006; Loughran, 2002). We borrow terminology from Donald Schön (1983, 1987 & 1995) to frame goals for the interventions: teacher candidates become consciously aware of tacit principles that drive their practice (theories-in-action), but also begin to learn to reflect-on-action (post-practice) and eventually to reflect-in-action (during practice) in order to transform their practice as science teacher educators.

Despite evidence of the lack of influence of teacher education courses on candidates' subsequent practice, recent analyses of effective teacher education programs offer promising ways forward through the use of transformative approaches, using teacher candidates' teaching experiences as a basis for learning through critical reflection and socio-constructivist dialogue (Beck & Kosnik, 2006; Darling-Hammond, 2006; Dillon & O'Connor, 2010; Korthagen, 2001; Loughran, 2002, 2006) as a recognition in the importance of the *authority of experience* (Munby & Russell, 1994). As a science education field, we know little about incorporating such new pedagogical approaches to practicum learning into traditional science education program structures. It is this significant gap in our professional knowledge as science teacher educators that this research addresses. In this paper, I explore the notion of a science pedagogy of place and its potential importance for teacher education.

Theoretical Frameworks

The development of science teacher candidates' professional practice during practicum and field experiences is of critical importance, yet our understanding of its development and its relationship to candidates' learning in education courses is extremely limited (Segall, 2002). What little we do know about candidates' development during practicum and field experiences suggests that education courses have little influence on their practice (Clift & Brady, 2005; Cochran-Smith & Zeichner, 2005; Wideen et al, 1998). Candidates tend to be socialized into the status quo of school practice or to reproduce their own school experiences (Tigchelaar & Korthagen, 2004; Tillema, 1998). As a science educator, I question the traditional teacher education process of exposing students to theory (coursework at university) and then practice (K-12 classroom practicum) as sufficient in promoting Schön's (1983, 1987) epistemology of practice. Schön's *reflection-in-action* is often unachievable within traditional teacher education programs as students rarely master learning from experience during science teacher education programs in a transformative way (Mezirow 1991, 1995, 1997) that gives them direct access to the experience, specifically an *authority of experience* (Munby & Russell, 1994) in developing knowledge from analysis of that experience. Munby and Russell coin the phrase *authority of experience* because of their "concern that students never master learning from experience during preservice programs in a way that gives them direct access to the nature of the authority of experience" (1994, p. 92). They present a challenge to teacher educators:

The basic tension in teacher education derives for us from preservice students wanting to move from being under authority to being in authority, without appreciating the potential that the authority of experience can give to their learning to teach. The challenge for teacher education is to help new teachers recognize and identify the place and function of the authority of experience. (p. 94)

Place-based Education

In part, by responding to Munby and Russell's challenge, MRU's Bachelor of Education program design seeks to embrace the authority of experience and is broadly rooted in a long tradition of *experiential* and *place-based education*, first articulated by Dewey (1938). In experiential learning, learners are first immersed in the experience of the targeted learning and then are asked to reflect on and analyze their experience in order to make sense of it. Kolb (1984) offers a working definition of experiential learning. "Learning is the process by which knowledge is created through the transformation of experience" (p. 38). In this view, learning is viewed as a continuous process grounded in experience as opposed to simple content or outcomes, knowledge is seen as a continuous transformation process of creation and re-creation rather than an independent and objective entity to be acquired or transmitted, and ultimately learning is seen as a process that transforms experience.

Although we often refer to the field experience/practicum as *experiential*, the practicum also incorporates constructivism as a theory of learning and, we argue, is inextricably tied to the field of *place-based education*. The notion of *place* can be described to those "fragments of human environments where meanings, activities and a specific landscape are all implicated and enfolded by each other" (Relph, 1992, p. 37). Place-based education is an approach to teaching that is grounded in the context of community, both natural and social (Penetito, 2009; Raffan, 1995; Theobald & Curtiss, 2000). It emerges from the particular attributes of a place. The content is specific to the geography, ecology, sociology, politics, and other dynamics of that place (Gruenewald, 2003; Woodhouse & Knapp, 2000). It provides a purpose to the knowledge and reasoning taught in schools; provides a contextual framework for much of the curriculum (gives meaning to the studies) and engages the student in the conditions of her/his own reality (Emekauwa, 2004; O'Connor & Sharp, 2013). Our B.Ed. science and math program is also deeply informed by Indigenous interpretations of Place:

In a curriculum of place the activities in which we engage children are the very activities they need to dwell in this place, to be nourished by the place and to nourish it. In a curriculum of place, young people or novices grow into knowledge through engagement in hand-on activities learning side-by-side with masters of the crafts. This knowledge enables people to find their way in that place where they dwell and this knowledge and these skills endow them with identity. (Chambers, 2008, p. 120)

The delivery of our teacher education programming might be best characterized as the pedagogy of place (Blood & Chambers, 2006; Gruenewald, 2003): the integration of the student into their home school (practice) and the reinforcement of the essential links between the student, their peers, and place through targeted course work (theory). Through this integrated process, teacher candidates make connections between their experiences in the schools and the theoretical course work and in doing so learn to trust the authority of these integrated sets of experiences.

As part of their science and math course work, 3rd year students take part in a wide variety of place-based activities, often in the company of scientists and educators who have been working in a

related field. They take part in intensive field studies that involve science inquiry and community activities conducted in a range of settings. Most of the activities involve environmental monitoring and most are longitudinal in nature as they span over a period of years. The community issues students address during their time in the science and math program are typically characterized as place-based educational initiatives. The ability to infuse an outdoor activity with related environmental field studies benefits the whole educational enterprise (Cajete, 1994, 1999; O'Connor, 2009). The linking of environmental field studies with an outdoor pursuit gives both the study and the activity additional educational value and meaning (Kawagley & Barnhardt, 1999; Smith, 2007; Woodhouse & Knapp, 2000). In addition, field studies reinforce both labs and lectures in specific subjects, addressing a traditional education problem: integrating theory and practice [Dewey, 1938]. Courses such as geography, survey biology, quantitative chemistry, ecology and environmental studies are often integrated and lend themselves to field studies that link to a range of outdoor activities. The field studies approach often takes on the mantle of place-based education since many of the field studies are centered on responding to community concerns, studying and collecting data and proposing possible responses to the community-defined problem. Addressing 'real' topics and finding ways to apply the prescribed learning outcomes to these studies have proven to engage students in ways that secure knowledge and strengthen positive community attitudes (Sobel, 2004). In this respect, including field studies with outdoor pursuits has been proven to be a successful educational approach (Louv, 2005; O'Connor, 2010; Raffan, 2003; Woodhouse & Knapp, 2000).

The ultimate goal of these place-based pedagogies is to have the teacher candidates not only see the relevance and importance of their studies, but also reflect critically since those studies have immediate causal effect on their present pedagogical context as professional teachers and, ultimately, the well being of themselves and their students.

Critical Pedagogy and Citizenship

As we attempt to provide experiential and place-based opportunities for pedagogical development, teacher candidates spend a considerable amount of time developing an understanding of a certain land base by conducting scientific, social and political assessments. This is often done with a critical lens, as students, with the support of community partners, are encouraged to debate resource extraction, land management and other contestable issues (Gruenewald, 2003; Kincheloe, 2005).

Critical pedagogy (Freire, 1970; Jardine, 2005; Kincheloe, 2001, 2005; Kincheloe & Steinberg, 1998) can help teacher candidates transform their teaching experiences into professional knowledge through a deeper understanding of the social, political and cultural reality of the educational context. Specifically, our science program utilizes problem-posing pedagogies rooted in local and contextual science issues and events that are inextricably tied to place-based education (Breunig, 2005; Raffan, 1995). Critical pedagogy supports a realistic approach to teacher education as it seeks to provide teacher candidates with opportunities to transform experience into knowledge that in turn informs their practice as they consider their experiences from a variety of framing positions. The literature on critical pedagogy suggests that the learning of new complex practices involves a good deal of unlearning and relearning and takes a good deal of time and support (Gruenewald, 2003; Kincheloe & Steinberg, 1998; McLaren, 2003). To assist us with these supports and, in addition to relationships through school-university partnerships, we have created numerous partnerships in experiential science education-related fields that build on our emerging relationships with organizations such as the Ann and Sandy Cross Conservation Centre, Telus Spark Science Centre, Tim Horton Children's Ranch and Fish Creek Provincial Park Society.

Within the environmental science field, it has become increasingly important to have an informed and critical citizenship prepared to embrace responsible environmental and social behaviors (Barr, 2003; Hines, Hungerford & Tomera, 1986). Here, I use Glaser's definition of citizenship: "Good citizenship calls for the ability to think critically about issues concerning which there may be a difference of opinion and apply democratic values to the issues. Critical thinking has three components: an attitude of carefully considering problems, knowledge of logical inquiry methods, and skill in applying those methods" (1985, p. 25). The genesis' of such citizenship rests in family, community and schooling that promotes responsible environmental behaviors. In the examination of the educational processes and social actions that lead to good citizenship, I posit that critical thinking is the central foundation (Freire, 1970; Gruenewald, 2003; Kincheloe, 2005).

Learning to think critically is conceptualized as the acquisition of the competence to participate critically in the communities and social practices of which a person is a member. If education is to further the critical competence of students, it must provide them with the opportunity at the level of the classroom and the school to observe, imitate and practice critical agency and to reflect upon it. Learning contexts must be chosen which students can make sense of and in which they can develop a feeling of responsibility for the quality of the practice in question. (Ten Dam & Volman, 2004, p. 359)

A crucial condition to critical pedagogy is it needs a context to be relevant and therefore be sustainable (Gruenewald, 2003; Penetito, 2009). Community issues in which frame place-based learning provide the context for critical thinking, situational conditions, and for attributes such as locus of control. Place-based educational activities focus on environmental and social values, situational characteristics and psychological variables; as community action is open to a range of varying and competing interests (Barr, 2003).

The conditions that give rise to responsible environmental and social behaviors are a major focus of place-based science educational initiatives (Louv, 2005; O'Connor & Sharp, 2013; Sobel, 2004). This paper explores the ways in which place-based science initiatives may be incorporated in school instructional strategies. These place-based educational initiatives focus on the development of citizenship focusing on a critical knowledge of social, environmental and political issues and associated action strategies, locus of control, attitudes, verbal commitments and an individuals sense of responsibility within a community.

Our theoretical framework of place-based teacher education is drawn from the literature on educational relationships and critical pedagogy with the intent to study theory-and-practice integration. In order to address our research questions crafted around this framework, we present a methodology that connects these dimensions with our investigation of place-based pedagogies.

Methodology

Drawing on the research involving self-study as a methodology for studying professional practice settings (Pinnegar, 1998), program improvement (Kosnick et al., 2006), and teacher education in Canadian contexts (Kitchen & Russell, 2012) and based on principles of self-study design (Dinkelman, 2003; LaBoskey, 2004), this research was self-initiated, focused on inquiry into our practice, collaborative, aimed at improvement of our practice, and using multiple and primarily qualitative means of inquiry.

This paper is informed by the initial results of a larger programmatic longitudinal qualitative study (currently in Year 2 of a 6 Year SSHRC funded study) that is designed to investigate the impact of transformative pedagogies by mentor teachers and teacher educators throughout teacher candidates' field experiences (i.e. weekly half-day school visits each semester) in years one and two of the program, practica experiences in years three (5 weeks) and four (9 or 15 weeks) of the program, and their initial year of teaching after graduation. Along with my colleague Gladys Sterenberg (Mathematics), as teacher educators we were concerned about how our teacher candidates were experiencing tensions between theory and practice in science and math education. We wondered how place-based pedagogical interventions might help us bridge this divide in a way that would help transform the typical limitations of the development of teacher candidates' teaching practice. For this paper, through self-study, I investigated teacher candidates' experiences of deliberate place-based pedagogical interventions such as environmental science field studies and inquiry projects and the role in-school seminars played in the process of science theory-and-practice integration.

The first phase of the project took place in fall 2014. In our four-year Bachelor of Education program, 3rd year teacher candidates spend 7-weeks in campus-based education course work and 5-weeks in a school placement. For this year of the project, seventy-five teacher candidates were placed in cohorts of four to six in eighteen elementary and middle schools. In order to encourage science theory-and-practice integration, teacher candidates were presented with related articles to read and an open-ended prompt to respond to in an online discussion forum for each of the 12-weeks of the semester. The readings, discussion prompts and in-school seminars facilitated by faculty reflected the five areas of competencies in our programs: planning for learning, facilitating learning, assessment of learning, classroom environment, and professional responsibilities. Teacher candidates were also asked to complete journal entries on a range of related science education topics. As part of their 12-week integrated semester, the teacher candidates participated in a minimum of 8-10 days of outdoor field studies; many of them based on local community environmental issues in a range of settings. The focus of the inquiry included the integration of science and math program of studies. We utilized numerous pedagogical frameworks to guide these studies, one of them being the *Global Learning and Observations to Benefit the Environment GLOBE program* (2015); an instrumental educational platform utilized to assist in engaging students in the field of experiential science. GLOBE is a worldwide hands-on, school-based education program that was crafted to develop an awareness of one's *place* in the natural world. Through the use of environmental science related activities and an integration of traditional ecological knowledge, students develop an enlightened recognition of the proper relationship of self, community and global world. Students collect field data and analyze various aspects of environmental study issues before developing strategies to address and take action related to community concerns. During the integrated semester, teacher candidates took part in a wide variety of place-based activities, often in the company of scientist and educators who have been working in a related field.

My colleague and I taught integrated sections of *EDUC 3106/08-Program of Studies Curriculum Instruction in Science/Mathematics* and *EDUC 3010-Practicum 1* within the 3rd year-fall semester of a 4-year Bachelor of Education program at Mount Royal University. Fifty third-year teacher candidates enrolled in these courses accepted invitations to participate in the complementary research studies that were dovetailed in design with the intention to improve the teaching and learning process. Together, we piloted school-based seminars in coordination with candidates' practicum experiences and science field studies and inquiry projects.

By deliberately integrating on-campus classes, off-campus field studies and in-school experiences, we hoped to gather data on teacher candidates' experiences of integrating theory and practice through in-school seminars. Data was collected in 4 cooperating elementary schools (that included student teacher cohorts of 6 participants in each school, cooperating elementary and middle school teachers and two professors). The participants in this study included two teacher educators, fifty teacher candidates, twenty-four mentor teachers, and six school administrators. During the 2014-2015 academic year, we conducted and recorded four focus group conversations with administrators and teachers from individual schools, two joint meetings with administrators from four partner schools, and ten in-school seminars with 12-18 teacher candidates, mentor teachers and administrators. Evidence of 50 participants' experiences was documented from class assignments (reflective journal entries, responses to discussion prompts, and a portfolio). As researchers engaged in a self-study, we engaged in bi-monthly collaborative research in-person conversations, exchanged in weekly online communications, and kept research notes about our experiences. At the conclusion of the year, we conducted individual interviews with a convenience sample of fifteen teacher candidates. Multiple data sources provided trustworthiness as experiences were explicitly documented and analyzed by the researchers in various forms and sites. Data was first coded individually across these sites according to emerging patterns and themes that related to our research focus on theory-and-practice integration (Erickson, 1986; Lincoln & Guba, 1985; Patton, 2002; Strauss, 1987). We then reviewed our analysis, collaboratively adjusted the codes, and explored findings together. Qualitative research methodologies were used to document existing patterns of interaction among those involved in candidates' practicum learning to provide baseline data on existing practices. These methods guided the development of place-based pedagogies designed to foster transformative learning (Cranton, 2006; Mezirow and Associates, 2000) in practicum experiences.

Results

For the purpose of this paper, I have included participant responses from the journal entries, recorded seminars/focus groups and individual interviews that have guided the research to date. As part of the research, the original participants' names have been removed to protect their identity. I also include portfolio reflections documenting their learning and professional goals.

Realistic

The extended period in schools (5 weeks full-time), integrated field studies (8-10 days) and environmental science inquiry projects (2 student-directed; semester-long) allowed students to approximate the work of science teachers to a larger extent than is normally possible in student teaching. The instructional activities address many learning styles, address "real" conditions and pose "real" problems.

It is hands-on, it's visual, and it's auditory... They get to see things like a frog, beaver or something foreign and then we [teachers] present a learning opportunity and connection right at that moment...that is it, it gets them interested in school but also helps them retain the information. We capitalize on their curiosity, it's beautiful.

(Tony, Seminar, 2014)

We are tying in environmental and community issues with education [climate-solar energy]. The kids recognize the change because they have been given a baseline and have done

assessments and compare them to that baseline. This is empowering to them...It's their community. It's their life.

(Shannon, Journal Entry, 2014)

These students develop skills that are professional life skills that they will carry with them after university and into the classroom.

(Gina, Focus Group, 2014)

This *realistic* approach to teacher education is based on experiential learning and the promotion of reflection on teacher candidates' teaching experiences through a constructivist learning process where "the student develops his or her knowledge in a process of reflection on practical situations, which creates a concern and a personal need for learning" (Korthagen, 2001, p. 15). The role of the teacher educator is not to impart theory as guidance to teacher candidates, but rather to foster *phronesis* using teacher candidates' practical experience as the base. *Phronesis* refers to a kind of practical wisdom that is concerned with the important specifics of particular situations as a way of not only understanding them well, but of deciding how to respond to them well. The intent of a realistic approach to teacher education is to transform experience into knowledge (Kolb, 1984) that reflects the social, political and cultural reality of the educational context (Kincheloe, 2003).

Reflection and Identity

Rather than being viewed as just the occasion to step back from their teaching, the self-reflective and socio-constructivist pedagogy employed in the school seminars were identified as the primary pedagogy that helped students make sense of their experience together and construct their emerging identity as science teachers. This science/math program was created not only to engage the teacher candidates but also to model a pedagogical approach of engagement of science students (K-9), encouraging their development in skills, attitudes and knowledge and helping them discover possibilities for their future as professional science teachers.

It's just like, "Is everybody experiencing what I am experiencing here? Are there any people doing the same thing?" And getting the feedback from the other people just made you feel so much better, and then hearing somebody else connect the theories to their practicum and you're just like, "Oh that works too". You just you wouldn't have thought about it in that way. And then getting everybody to say something about it you just keep... You think more. You answer more. And that's the best feedback.

(Nicole, Interview, 2014)

I also feel that when the seminars were at the school, I felt like there is a greater responsibility to act in a way that is professional and as a result, I felt like more of the realities of being a teacher were present while having the conversations and I had to approach the conversations more with the mindset of a teacher.

(Bill, Journal Entry 13, 2013)

Honestly it impacted my awareness of my practices because listening to the stories of other student teachers, of course, made me constantly reflect on what I was doing because you hear their stories – the good and the bad, and the frustrating and the nerve-wracking – and you always relate it back to yourself... I think your practice changes without you really noticing, and I didn't really notice until the practicum ended and I really thought about what I did. And the seminars throughout the practicum made me feel better at times, and worse at times, but I think they were crucial for development.

(Abbey, Interview, 2014)

If we wish to prepare our teacher candidates for the present and future, they must be immersed in the *authority of experience*, the knowledge-in-action that helps teacher candidates respond critically to change. Many students discredit their own experiences as they place more authority with those who have experience and speak with confidence and assertion about what it takes to teach. Students are hesitant to validate and have faith in their own experiences as a guiding basis for knowledge and professional development in their teaching practice. Learning to trust oneself and one's own wisdom gained through reflection upon experience is critical to a strong sense of professional identity (Munby & Russell, 1994).

Significance of Relationships

Students' learning was enhanced by the supportive and trusting relationship between students and the teacher educators in the program, as well as the collaborative and supportive relationships that developed within the field studies & inquiry project groups, seminar groups and school communities. Teacher candidates, mentor teachers, students, and community members work together as groups and teams. Everyone involved helps each other acquire skills, attitudes and knowledge in a collaborative process.

I found that the in-school seminars provided a unique experience to connect with fellow MRU students... I felt that these seminars also helped to create a feeling of community in the Education program. Connecting with other Education students has proved to be a great resource for me personally. It makes a huge difference when you know people who are going through the same things as you are as a new teacher.

(Rhonda, Journal Entry 12, 2014)

When we were in our seminar, the two, I think kindergarten and grade one teachers, they came in and they were telling us about classroom management and the different ways, like when they started off first year teaching how crazy it was and how stressed they were, and then the different ways they figured out for themselves. So it was kind of like oh I could try those techniques when I am a teacher, or when I am teaching that lesson really.

(Sybil, Interview, 2014)

The teaching seminars, going in and being able to talk to other student teachers and educators and be around them... knowing that you are not the only person who is making these mistakes, and you are not the only person who is going through this, is a huge support. And sharing—it is amazing! It helps support your confidence and it is a good check-in to say, 'You know what? You are okay. You are doing okay and you can keep going. Don't give up,' like it is a good support system to have.

(Sheila, Interview, 2015)

A fundamental dimension in the delivery of our B.Ed program is to cultivate and support relationships through the development of partnerships (Bacharach & Hasslen, 2001; Loughran, 2002) and robust communities of practice (Lave & Wenger, 1991; Wenger, 1998) that enhance teacher candidate professional learning. The kind of experience that students had through this alternative and integrated science/math program is rare, if not unique, in their overall University program. One probable reason for this contrast is the institutional context that works against the development of healthy and sustainable school-university partnerships in many teacher education programs. Large (that is, cost-effective) and campus-based (run and controlled by the university) courses that foster impersonal anonymity and priority placed on theoretical research and scholarship erodes time devoted to candidates collaborating and developing supportive relationships contribute to that context.

Place as Pedagogy

The students valued the seminars and field studies that were held in participating schools and in the natural field study environments rather than back on campus (as is for students in many traditional teacher education programs) and noted that this created a hybrid school/community-based semester. The instructional activities address community, local situations and involve a wider community. Activities are often chosen as they involve addressing community issues, concerns and/or resources.

I think the big way of phrasing it is, being at the schools [elementary/middle] or in the field, it's very much so more focused on the students we are working with... and yet, if we did it here [on campus] we would be back in the frame of mind where we are the students as opposed to teacher candidates. And there's that switch where suddenly we're not in the environment where it's the students we are working with are the focus, because we are back here. And so, I think that's one of the big things is the environment we are put into kind of fosters these sort of conversations we are able to have.

(Terry, Interview, 2014)

[In-school seminar] we were talking about the "teaching presence", we kind of reflected on it as a whole group in the school, and then I went into my class. I found I was more aware of, and maybe more confident in it. You can think a lot of things by yourself, but when you have other people who are almost validating it, or being like, 'Oh yeah, me too,' or, 'That is neat,' and you are in the school talking about it... I don't know... in the school Kevin made us think of certain questions we would ask ourselves and those questions are kind of in the back of your mind when you go back in class and you are, 'Okay, I can be this way, a professional'.

(Megan, Interview, 2015)

When you are thinking and acting in that [immersion] deep way, when you are connected to the land, learning in a practical way, the retention of the material is tenfold... We went out and worked in the river for half a day. Without knowing anymore, just were engaged in the river, observe, detailed observation... the objective is to come back and explain what you saw and what you now think you know about it based on what you have just seen. It is the little things like that are some of the most powerful teaching tools of the program.

(Chris, Focus Group, 2014)

As educators, we were struck by the increase in engagement level demonstrated by our teacher candidates. Not only were they excited and passionate to discuss and engage in the studies, they brought a heightened level of professional conduct and expectations that required us, as facilitators to “raise our game”. Gladys and I spoke often of how we felt like “true” facilitators, as we would consistently be mediating the educational needs of our students (as defined by our course requirements) with the opportunities arising through community engagement and environmental field studies and data collection. The seminars and field studies were challenging as we attempted to meet the competing demands of the participants (teacher candidates, mentor teachers, school administrators, scientists, and community partners) interests needs and worldviews.

Integration Through Place

Finally, the multidisciplinary approach, which integrated both the science curriculum courses, frequent field study opportunities, 5 week integrated practicum and in-school seminars promoted a relational aspect to knowledge (i.e. Place-based Education). The integrated semester linked many “subjects areas”, pedagogies and community interests in addressing projects and studies. These links are often synergistic, yielding more learning than the simple sum of the two subjects addressed.

One thing I found was everything being tied together at one point, and sometimes the seminar would kick in to help with what was going on with some of the written work, especially with journals being tied to seminars, I could tie in things that we talked about. Because some of it clicked after our conversation that didn't click before, or something that I'd written in my journal helped click the next concept in class. Everything being tied together worked really well

(Terry, Interview, 2014)

[We would] share a little story about how we were doing what we did the week before and then we would go into talking about something that relates to the textbook based on what we were doing in the field, and then we would all collaborate on different ways we could assist each other, or that we could handle problems and stuff. I thought it was really helpful to have that.

(Kristen, Interview, 2014)

When you think back on everything we have done, it seems so long ago when we started our courses but at the same time it does not feel like we have stopped our journey...just different parts yet it all seems connected. All the parts (alternate pedagogies) were connected in some way and it now seems we used them and brought them together in our time in the schools. I have nothing to compare this to but after talking to my Mentor Teacher and the other student teacher [from another University], we get a lot of support which I think really helps us, especially when it comes to our teaching.

(Dave, Seminar, 2014)

The interconnectedness and the understanding of the relation of things, which is a key component to both experiential learning and place-based education, became a fundamental component of our science/math program design. As many teacher education programs focus on top-down lessons, single-discipline course design that fragment subject matter, the holistic component of learning, in which learners organize information globally and derive meaning from the relational aspects of the concepts, was promoted through an integration of practical subject matter. We often ran into resistance by colleagues and partners, as this is often not a conventional, comfortable or popular

approach to teaching and learning. Enacting our vision with partners was laborious and time consuming as there were many instances throughout the semester where I struggled with its sustainability. In those times of disillusionment, I would often pull out the following quote from a long-time colleague and Yukon educator who eloquently speaks to how integration and place are antecedents of teaching and learning.

When we speak of pedagogies and experiential education, I like to use the metaphor of a 'symphony of music', many notes to make the beauty and capture the imagination of the listener. We cannot only use one note or one verse, as this is too narrow and misses many different learning styles. This analogy speaks to the integration of the curriculum, community input and 'lived experience' versus 'planned experience'. I argue that curriculum as lived is a planned activity, pedagogical relationships can be organized. As a teacher, I look for those 'teachable moments', and the 'opportunity knocking'. Teachers may not have all the specifics premeditated in a detailed lesson plan but they need to have the ability to recognize and use activities, people, ideas, events to bolster or support the understanding and motivation of the student to pursue further and to assist in the retention of the curriculum.

(O'Connor, 2009, p. 169)

Conclusion

Place seems to have a powerful effect on the development—or lack of it—of future teachers; students seem to resist changing from the person under authority to the person with authority. The use of place-based pedagogies seems to have disrupted, at least to some extent, the authority of position while also addressing the traditional distance created as a result of the separation of courses and the practicum. A consideration of place still leaves the question of the role of campus-based courses in a teacher education program and their relationship with students' school-based learning experiences. The extent and nature of the teacher candidates' responses to the research shows a community of practice (Wenger, 1998) of young adults involved in community and a heightened understanding of 'place' in active ways. They express the significant role this type of educational experience has influenced their professional development. Most participating students felt a sense of social and environmental responsibility, values I suggest are needed in science education.

Those participating in our program demonstrated an uncommon level of engagement and environmental responsibility. These teacher candidates refer to the challenging and significant place-based field studies, the co-operative work relationships that develop during their semester and diverse instructional processes used throughout the program as features that impacted their development as learners and teachers. Field studies resonated with those students who learn best experientially and in social contexts. A number of teacher candidates indicated they struggled with conventional classes yet found success and engagement in the environmental field studies approach to courses.

The development of teacher leaders who internalize community and global challenges, are proficient in theory-practice integration and place-based pedagogies related to science education appears to be an essential aspect of preparing new science teachers for the complexities of not only the science curriculum but the educational context in general. This research sheds light on how a university teacher education program may contribute to such development. This research provides compelling qualitative evidence indicating that educational processes involving place-based activities

that encourage data collection, reflection and action are important antecedents to responsible and sustainable science education pedagogy.

One's experience of a place includes a complex combination of a specific physical environment, "our embodied encounter and the cultural ideas that influence the interpretations we make of the experience" (Wattchow & Brown, 2011, p. ix). This provides rich potential for science teacher educators who are versed in place-based pedagogies. A teacher candidate learning about the significance of a place, and how their beliefs and actions impact upon it, will be well positioned to reflect on how their pedagogies may need to adapt to the challenges of teaching and learning science. If the initial results of this self-study are indicative, far greater attention must be paid to the notion of place in the education of future science teachers.

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