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# Investigating the Impact of a Practicum Experience in an Aquarium on Pre-service Teachers

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This study investigated the impact of a three-week pilot practicum experience in an Aquarium setting on secondary pre-service biology teachers' epistemologies and pedagogies of teaching and learning. A qualitative case study methodology was employed to examine the experiences, views of teaching and learning, and teaching development of a small cohort of pre-service teachers who participated in the practicum experience in the Aquarium as part of their teacher education program. All pre-service teachers in the cohort experienced profound changes in their views of what it means to teach and learn, gained confidence in their ability to teach, and felt empowered as science educators following their teaching in the informal setting. Participants developed broader views of education, increased understandings of the educational theories of constructivism and of 'teachable moments', and broader skills of teaching K-12 students. The study illustrates the potential of re/forming teacher education programs to incorporate practicum experience that goes beyond classroom settings.

## Introduction

In recent years there have been multiple calls to reform pre-service teacher education (see Darling-Hammond, 1999; Feiman-Nemser, 2001; Korthagen, Kessels, Koster, Lagerwerf, & Wubbels, 2001). A number of the programs being proposed indicate a need for increased collaborations involving university and internship schemes (Benton, 1990; Furlong, 2000; McIntyre & Hagger, 1992). Metz (2005) suggests that pre-service teacher education programs need to be more collaborative with the informal education sector (museums and science centres) as a means of identifying practices that can make field experiences more authentic and powerful learning adventures. In keeping with the sentiments of this appeal, in 2005 the University of British Columbia's (UBC) teacher education program partnered with the Vancouver Aquarium Marine Science Centre<sup>1</sup> to develop and pilot an innovative practicum

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experience that sought to expand and re/form the definitions of teacher education. Among the teacher education programs at UBC, there is currently a 12-month degree program that enables candidates holding bachelors degree qualification in a science discipline to complete a B.Ed. (Bachelor of Education) degree in secondary science education. This program leads to certification as secondary science teachers in the province of British Columbia, Canada. The practicum model within this degree program comprises two phases of classroom practicum experience—two weeks in the early stages of semester one, and thirteen weeks extended placement in semester two. The practicum experiences are designed to help students connect pedagogical theory with practice; provide teaching experiences that provide preparation for a career in teaching; encourage pre-service teachers to reflect systematically and analytically upon teaching in a professional and educational community (the school and classroom); and create opportunities to plan, implement and evaluate instruction.

The partnership was initiated in an attempt to re/form this traditional classroom-only model of extended practicum to one that consisted of a 10-week classroom placement followed by a three-week teaching experience in the Aquarium setting. As part of our initial attempts to reform the traditional practicum model, we inaugurated a pilot program for a cohort of eight pre-service secondary biology teachers. Although other B.Ed. programs offered by universities in Canada have included opportunities for pre-service teachers to include museum-based<sup>2</sup> experiences as part of their practica, this was the first cohort model implemented by a Canadian university and museum partner.

The rationales for this change were numerous. On the university side, there was a concern that practicum experiences offered in school-based settings were not in keeping with broader definitions of teacher education. Teacher education in our view is about equipping educators with a wide range of skills that can be readily transferable across contexts, inside and outside of school settings. It should provide pre-service teachers exposure to and opportunities to practice in a wide array of learning environments. We also felt there was a need to help the pre-service teachers to expand their views of science teaching and learning beyond the boundaries of the classroom-based environment and to provide first hand experience that would equip them to move beyond textbook-based science teaching. To these ends we believed that the non-formal environment are ideal for providing the hands-on, student-centred, and activity-based pedagogy called for by contemporary science educators. The institutional views of the Aquarium were congruent with our university views. In addition, the Aquarium saw the practicum partnership as an opportunity to: influence the next generation of teachers about how to effectively use the Aquarium facility with their classes; shape attitudes of beginning teachers; propagate messages of conservation and ecology through pre-service teachers to multiple generations of students; have an additional source of expertise to redevelop and influence programs and resource materials; and increase visibility and demonstrate additional impact in the community.

The research objectives of this study centred on investigating the impact of a practicum experience in an Aquarium on pre-service teachers' pedagogy and epistemologies of teaching and learning. We come to this study with the following

ontological and epistemological underpinnings: First, learning to teach occurs across contexts and is not limited to school-based classrooms (Bruner, 1996), and second, learning is dynamic and not the domain of any one single context or experience (Flavell, 1987). Thus becoming an effective teacher practitioner requires experience in contexts beyond the limited confines of school-based classrooms. School field trip venues such as science centres, museums, and aquaria are among the important learning sites where students ought to be encouraged to manage and direct their own learning (Griffin & Symington, 1997), thus a partnership with one such venue seemed a logical starting point for broadening the practicum experience.

Reports of teacher education programs at universities that include extended placements in museum settings are limited. Moreover, there are very few systematic research or evaluation studies that have considered the impact of such placements on pre-service teachers' epistemologies and pedagogies of teaching and learning. Middlebrooks (1999) considered the impact of short-term internships at museums on pre-service teachers. She concluded that such partnerships are beneficial to pre-service teachers in that they provide opportunities to: (1) work with children of different ages; (2) observe different teachers in their pedagogical practice; (3) practice science teaching; (4) have ready access to help from museum staff once they become teachers. Olsen, Cox-Peterson, and McComas (2001) investigated the views and perceptions of 64 pre-service science teachers in three different teacher education courses offered in three different universities in California. Pre-service teachers reflected on their experience of taking their classes on a single field trip visit to a science-based institution while on their practicum. Focus group discussion and analysis of a post-field trip questionnaire indicated that pre-service teachers' concerns were primarily managerial in nature, that is, their focus of attention was largely on aspects of running the field trip—organizing buses, collecting money, behaviour management, permission slips, and organizing chaperones. A study by Lauriala (1997) of two case studies from a Finnish university examined how innovative student teaching practica in novel classroom settings<sup>3</sup> affected student teachers' professional knowledge. Data from interviews with students, student reports, and student narratives indicated that the experience made them critically examine their often tacit assumptions, and restructure and reflect on their professional knowledge. Taken together these studies hint at the value of rethinking and re/forming the practicum to encompass broader learning opportunities for pre-service teachers. Further, Olsen *et al's* (2001) study suggests that to take full advantage of the learning-to-teach opportunities afforded by non-formal settings, pre-service teachers may need a more extended period of practical experience in such settings.

### **Nature of the Aquarium Practicum Option**

The Aquarium practicum we describe here consisted of a three-day facility initiation and program orientation experience, and a subsequent three-week practicum placement that took place after a 10-week school-based practicum. During the

training sessions the pre-service teachers were given an orientation of the Aquarium facility and an introduction to its educational programs. School programs, designed by the Aquarium for classes making field-trip visits, address the provincially-mandated curriculum. Specific programs for students focus on such things as developing inspiration, curiosity and marine stewardship by exposure to animals; discovering the importance of ecosystems; promoting awareness of the historical, cultural, and economics aspects of the fishing industry; and acquiring knowledge of diversity and ecology of live marine invertebrates from local waters. The pre-service teachers met with each of the Aquarium's school program coordinators who introduced them to the school programs offered by the Aquarium. Additionally, they participated in activities designed by the Aquarium educational personnel to model the hands-on, student-centred philosophy of education espoused by the Aquarium. Throughout the training the pre-service teachers were encouraged to contribute to discussions about education, teaching, and learning in informal settings. Following completion of the three-day orientation program, the pre-service teachers moved on to secondary school classrooms where they completed an intensive and requisite 10-week practicum. At the end of those weeks they returned to the Aquarium for their three weeks of teaching in the non-formal setting.

During their three-week Aquarium practicum pre-service teachers were involved in both teaching and developing materials for 10 to 13 curriculum-based school programs offered by the Aquarium for students from pre-school to Grade 11. The pre-service teachers began their practica by observing the school program coordinators and volunteers as they taught the programs. Pre-service teachers initially worked with a partner to team-teach one or two programs but within a few days each individual assumed responsibility for teaching one or more programs on their own. Teaching in the Aquarium included meeting, greeting, and organizing school groups, introducing and concluding the program activities, and teaching of the curricular elements and activities to the school groups.

During the third week of the Aquarium practicum the pre-service teachers participated in designing and developing pre- and post-visit activities for the school programs that they had been teaching. This was undertaken at the request of the Aquarium educational personnel who regarded the pre-service teachers as knowledgeable and creative. Individual pre-service teachers worked closely with the appropriate school program coordinators in this endeavour, and some worked collaboratively in pairs to discuss and develop the activities. The pre-service teachers revised and produced new curricular materials and activities; they related the activities to both the objectives of the Aquarium program and provincial prescribed learning outcomes for specific grade levels in multiple curriculum areas. Throughout the three-week practicum the pre-service teachers met informally with each other and with the Aquarium education staff members to discuss and reflect upon their teaching experiences. They also met formally with their UBC faculty advisors on a weekly basis. These meetings served as discussion forums for the students to reflect upon their learning and development as teachers.

## **Methodology**

This research study employed a qualitative, interpretive case study methodology (Merriam, 1998; Stake, 1995). The study sought to understand the impact of Aquarium practicum option on the participants. This kind of qualitative research seeks to provide rich description of the experiences of the participants, and to generalize conceptually about the nature of experiences. Consistent with the method of case study, our study included data collection through multiple methods and from multiple sources (Merriam, 1998). Data collection involved the following three methods:

1. Two focus group discussions were conducted with the participating pre-service teachers. The first focus group took place immediately following the training sessions; the second focus group took place after the pre-service teachers completed their practicum at the Aquarium. Each focus group discussion was one hour in duration and took place at the university. The focus group protocols were co-developed by the investigators, and consisted of a series of open-ended questions designed to inform the specific aims of the study. The focus groups were video-recorded and transcribed for subsequent analysis.
2. Every pre-service teacher in the pilot project cohort wrote three reflective pieces, one at the end of each week of their Aquarium practicum.
3. Observations of the pre-service teachers were conducted during the pre-service teachers' training at the Aquarium, and of their activities during the placement at the Aquarium. Field notes were used to document the events of the weekly practicum group meetings between the pre-service teachers and the faculty members.

Data analysis was conducted by the research team who viewed the videos of the focus groups. Transcripts of the focus groups, field notes and reflective pieces were then read independently and coded for emergent themes. The themes were manifestations of the impact of the practicum across the participants. The team met to discuss and compare their analyses and developed a collective interpretation of the data set (Stake, 1995; Strauss & Corbin, 1988). The final interpretations resulted in 10 themes. Each theme is discussed in the findings that follow, supported by verbatim quotes that are representative of the voices of the participants (using pseudonyms).

## **Outcomes**

Analysis of the data sets provided evidence of the influence of the practicum experience in the Aquarium on the participants. Based on our observations and interviews we identified 10 themes that illustrate how pre-service teachers changed through their individual and collective participation in the practicum. A common element among these 10 themes is the transformation of the pre-service teachers' thinking about education, teaching, and learning.

*Theme 1: Broader views of education*

The Aquarium practicum offered the participating pre-service teachers the opportunity to look at education and teaching from a broader perspective. Several of the pre-service teachers identified a concern that their initial experiences in their B.Ed. had been narrowly focused on teaching in the classroom. Pre-service teachers embraced the opportunity to expand their thinking about education to other contexts, and to experience teaching and learning in out-of-school settings.

I've felt a little bit that up until to this point that we've been doing a Bachelor of classroom teaching in the public education system as opposed to a Bachelor of Education and this [Aquarium practicum] is really opening doors. I find some of the really basic philosophies that we've been learning about are applicable in so many different settings and it's great to see a new setting ... (Kathleen)

I had an idea reinforced that I felt was being eroded by the rest of the education program, because they [at the university] always do this: "Then you'll do your practicum, and then you'll get signed off on this, and then you'll send this stuff away to BCCT (British Columbia College of Teachers), and then you'll be a teacher". ... I think it's really nice to recognize people in other unconventional forms of education as also being teachers ... (Andrea)

*Theme 2: Critical thinking about the 'big picture' in teaching*

The pre-service teachers indicated that the Aquarium practicum provided them with an opportunity to think about the 'big picture' in their teaching. They felt the Aquarium practicum challenged them to reflect on what is most important to them in their teaching. There were specific moments of epiphany amongst the pre-service teachers during their Aquarium practicum experiences regarding what should be in their 'big picture' of teaching. Kathleen's comments illustrate how her experience caused her to think critically about the overall goals of education.

It forced me to have this epiphany, kind of, yeah it was sort of an epiphany. And I feel a bit cynical saying this, but when we were there at the Aquarium they were like, OK, our objective here is conservation education, how do we get there? And then I thought to myself, what IS the objective in the classroom? And I was thinking about that and I'm [realizing], I don't know what the objective is in the classroom. What are we trying to do other than impart a certain amount of discrete knowledge?

Marissa was similarly moved to reflect upon her own philosophy and values as a teacher.

I actually sort of had an epiphany too. ... I realized, re-realized I guess, the responsibility of weaving in huge concepts like conservation ... my conceptions of being a teacher are that, to remember what is important I guess to me, what I think are important values, and to be able to highlight them without feeling overwhelmed by the curriculum and the things that we're supposed to get through. So it's really just remembering to push yourself to get to the stuff that's important in there as well ...

Mary experienced a personal revelation with respect to the relevance of education in informal settings for First Nations education.

[During university coursework] I was trying to think of how to approach First Nation learning and I had no idea how to do it. I had never had any experience with informal learning, or learning outside of the classroom, and at first it was difficult to adjust to the lack of structure. Then, I realized this type of setting is closer to the traditional form of learning that First Nations people should be receiving. I started pondering learning and how to deliver the curriculum.

We believe these students' words attest to the power of the Aquarium practicum experience in facilitating deeper thinking and reflection about the 'big picture' in teaching.

*Theme 3: Increased understandings of the educational theory of constructivism and of 'teachable moments'*

The pre-service teachers in the cohort group stated that in the Aquarium setting they were able to see in use, and apply many of the educational principles that they had learned about in their B.Ed. program. For several of the pre-service teachers this was their first opportunity to truly see the learning theory of constructivism in use. Others expressed that the concept of a 'teachable moment' really came to life in their teaching at the Aquarium, and the practicum helped them to develop pedagogical techniques to take best educational advantage of these moments.

I think being in that setting helped me to figure out a little bit more, in my own mind, kind of what constructivism is. Some days I think I understand it, other days I think I really don't, but having those kids just come in and plunk themselves in front of you when you've never met them before, and all of a sudden, especially with the Grade 11s it was really obvious, you really needed to take the time to figure out where they were coming from, what they had done so far, or it was just not going to work kind of thing. And trying to build on their existing [knowledge], it just became so much more obvious in that setting, so much more pointed I found. ... Yeah, I never got it in a classroom setting in many ways. (Kathleen)

Another thing that I think was a real highlight was [sic] the teachable moments that came up—just so many of them—one after another, because we were in such a stimulating environment where there were so many things happening. ... Some kid would point to a sea star and say, "that's an octopus", and I'd say "well, no, that's not an octopus, let's try to discover what it is", and we could go, we could look at it and talk about the different parts of it and kind of discover that, oh it's a sea star. Or the whales would be doing a particular behaviour and they'd say, "why is that whale doing that?" And I'd say, "well why do you think a whale would do that?" ... Just a lot of opportunities with such a dynamic setting to say, OK, oh look your interest is over here, well that's great we can talk about this now. Really teach whatever they were into at the moment. (Andrea)

*Theme 4: Broader skills in teaching students from K-12*

The secondary pre-service teachers felt they learned a great deal from their experience of working with and teaching students in all grades. For example, they gained firsthand knowledge about the cognitive and behavioural development of

children from kindergarten to high school, and learned about what pedagogical strategies work best with the various age groups. They also valued the opportunity to examine and work with the elementary curriculum (K-7) while developing the pre- and post-visit activities. They spoke about how the skills they gained in working with elementary children would help them as secondary teachers because they now had a clearer understanding of secondary students' backgrounds and previous school experience. For example Andrea, who had come into the secondary pre-service program with some elementary experience, felt enriched and enlightened.

I found it a great learning experience to be back with Grade 2s, 5s, 6s, 3s. Just really seeing how each age is really focused on different things, and some age groups aren't very focused at all, and seeing what strategies work with each group.

Marissa suggested an elementary experience would enhance the learning-to-teach experience of secondary pre-service teachers: "I think it was a huge benefit to us to see elementary students ... I think all secondary teachers should have experience with elementary because you need to know where they come from".

*Theme 5: Enhanced skills in flexible pedagogy and increased sense of autonomy to try different pedagogical techniques*

The pre-service teachers expressed that the dynamic and emergent nature of Aquarium education setting helped them to develop skills in flexibility in their teaching. In their view, the Aquarium teaching experiences afforded them opportunities to teach in a manner that was responsive to both the interests of children, and the dynamic behaviours of the organisms in the Aquarium exhibits.

While flexibility was something I was inviting partway through my formal practicum, it seemed rather scary and intimidating early on in a classroom setting. The Aquarium only enhanced my budding comfort in flexible pedagogy, because you HAVE to be flexible. (Rachel)

One of [the gains I made] is [understanding] the difference between teaching what is happening or what students are interested in, and teaching what we're rigidly told what we have to teach ... if the kids are really interested in the whales, but you're really focused [on] I have to get through, you know, the sea otter stuff, you can actually just go to the whales and get them [inaudible] what they're actually interested in and what they're going to learn about. (Sam)

Furthermore, the pre-service teachers felt a sense of freedom and the autonomy to try different pedagogical techniques. Because they taught the same program several times during the Aquarium practicum they were able to experiment with strategies, reflect *in* and *on* their practice, and gauge what methods worked best to teach different children the concepts. The pre-service teachers really valued the higher level of independence afforded to them in their teaching at the Aquarium. They also noted that exploring new teaching techniques was not encouraged, and could be in fact quite costly, in their classroom practicum.

[I] started out with this great broad view of education as anything that could happen with students and learning. Then through my [classroom] practicum I had teachers go “Oh no, no you can’t do that in the classroom... they aren’t mature enough for that”. I really kind of felt that the ways I could teach were starting to get more and more limited. And then I got to the Aquarium and it was great to feel like, OK yeah, I can try all these different ways of teaching again and I can really experiment with what ways are going to be the best ways for these kids to learn. All these things that I would have liked to have done on my [classroom] practicum with my grade elevens, some of them I was able to try doing in the wet lab [at the Aquarium] and worked out really well. (Andrea)

*Theme 6: Deeper appreciation for the value of working collaboratively*

The pre-service teachers expressed that the collaborative nature of the Aquarium setting contributed greatly to their professional development as teachers. They were engaged in continuous learning about teaching and education through the opportunities afforded to them in the Aquarium practicum for joint discussion and reflection on their teaching experiences. The pre-service teachers valued the opportunity to work closely with one another and with the many Aquarium educators and noted the contrast in the level and nature of collaboration at the Aquarium with what they had seen in the school setting.

I found the opportunities for constant learning and collaboration really high in there [the Aquarium]. Whereas I found that in the school I mean they made real efforts, there were professional days and we had department meetings, but that’s when it happened and otherwise you could go a whole day without talking to another a colleague or an adult. You really had to go out of your way to keep learning new things. Whereas [at the Aquarium] ... there were always people around and [we] just talked about new developments a lot more. (Kathleen)

I think another thing that enabled us to do a lot more exploring [of] our own teaching was that we were together in a group, whereas it wasn’t just one student teacher, one sponsor teacher, and 180 kids, go! [We] had time and kind of had invested a lot of time already practicing teaching, and now we were coming back and reflecting on what had happened in our practicum and what was happening in this informal setting. There was a real atmosphere that we were really interested in talking about education, exploring how we could become better teachers. (Andrea)

*Theme 7: Gains in self-confidence and self-efficacy as teachers*

We observed the cohort students gain confidence in their ability to teach and make sound educational judgments over the course of their practicum experiences at the Aquarium. Although these gains varied in their magnitude, there were several notable and profound transformations in self confidence and self-efficacy. In these cases, the pre-service teachers were able to clearly identify that the Aquarium practicum helped them to overcome some of the professional and personal struggles they had experienced in their classroom practica.

This week was a great way to restore my confidence about being a successful educator. After a practicum that had some particularly trying behaviour management moments, I

was beginning to question my competency as an educator and my interest in the profession of teaching. ... It reminded me that I like students at all ages and that I like teaching. (Andrea)

I have also noticed that I have gained more confidence in my teaching abilities and strategies ... I have also noticed a change in my assertiveness with students. Perhaps this is due to the younger age groups that I was dealing with but regardless, this was something that I definitely struggled with in the first part of my practicum ... I'm glad to know that I have it in me to be the leader that I need to be as a teacher. (Karen)

#### *Theme 8: Awareness of and development of student management skills*

Pre-service teachers expressed that during the Aquarium practicum they further developed their student management skills, in ways they will be able to apply in their future classrooms. This development came from the opportunities they had to work with diverse groups of students at the Aquarium, and also from observing how teachers participating in the Aquarium programs were managing their classes.

What kind of classroom management or rapport they [the teachers] had set up with the students—it was really obvious. ... There was one kid who was misbehaving, and the student teacher couldn't get him under control, both Mary and I were saying, whoa, we can see what's going wrong right here. It was a great insight into, oh this group's off the wall, oh look how the teacher's handling them. OK, if I don't want my Grade 3s to be off the wall, maybe I shouldn't do this. (Andrea)

#### *Theme 9: Recognition of the power of 'hands-on' experiences in learning science*

Through their participation in the wet-labs and programs involving live aquatic species the pre-service teachers gained an appreciation of the power of 'hands-on' experiences in students' learning. Observing the response of students engaging with living organisms helped them realize the value of bringing the 'real thing' into their future classrooms, or moving beyond the classroom to enhance their students' learning of science.

I really liked being able to do the hands-on stuff with the students, like the wet lab. Not only look through the glass, see that orange thing that's the sea pen. It's like, no, here's a sea pen. (Rachel)

It was quite interesting changing surroundings from a classroom to the Aquarium and recognizing the opportunity for visual and tactile information gathering. (Sam)

#### *Theme 10: Improved preparation to take students on field trips*

The pre-service teachers expressed that the Aquarium practicum placement was beneficial in preparing them as teachers to take students on field trips to museum settings. Their curriculum development work with the Aquarium program personnel was particularly valuable as it helped them reflect on the importance of preparing students for a field trip and of fully integrating the field experience into classroom learning.

I think the activities [we developed] were quite a bit of work, but they made me think more about why I would want to have field trips and how to make them useful in the classroom. I think a lot of teachers don't use field trips to their full potential. You can really use them to punctuate what you have been covering in class, or introduce something new. (Mary)

## **Summary and Conclusions**

The data illustrates that participation in the Aquarium practicum contributed to the cohort members gaining a holistic view of teaching that transcends the narrow bounds of the science classroom, and an experience that will aid them in their professional careers. They not only enhanced their techniques for teaching science at the secondary level but also acquired appreciation of, and skills in teaching elementary students. The dynamic and changing nature of the Aquarium education context required the pre-service teachers to be highly flexible in their pedagogy and responsive to the learning milieu. The Aquarium teaching and learning environment, including the enthusiasm and support of the staff, appeared instrumental in increasing their self-efficacy and positive identities as teachers.

Involvement in program delivery and curriculum/resource design at the Aquarium helped the pre-service teachers reflect on and identify the value of constructivist learning theories they had heard about in their university coursework in teacher education. The teaching and re-teaching of programs to diverse groups of young people helped the participants in our pilot study recognize the value of assessing children's prior knowledge and the importance of working with that knowledge in designing and implementing science lessons. The Aquarium context with its sensory-rich environment and live organisms in a range of habitats provided emergent opportunities to teach about nature, the environment and the science at hand. As they taught in the context the pre-service teachers could see and experience the principles of constructivism at work—both the individual and social aspects of constructing understanding became apparent in this learning environment.

An unanticipated outcome of our pilot was the value students gained from participating as a cohort. We learned that the cohort model adopted for this practicum innovation not only contributed to the pre-service teachers learning about teaching through their working together to discuss and reflect upon their pedagogy and educational philosophies, but also helped them to realize the importance of collaboration for their professional development in teaching. The peer interaction, as well as interaction with other Aquarium educators helped the participants to develop their skills in collaborative modalities of teaching, and to recognize the value and strengths of such modalities.

Taken together these findings indicate the novice teachers in this pilot study were clearly transformed, and broadened their epistemologies and pedagogies of teaching. They made gains in confidence, acquired new teaching skills and understandings of curriculum planning and classroom management, and were able to see for themselves the connections between theory and practice. We are encouraged by these outcomes from our pilot program and have already begun to expand this practicum

initiative to include partnerships with other museum settings that includes examination of the long-term impact of this program on learning to teach. Our future plan is to provide museum placements as a regular component of the teacher education program for all students across curriculum areas in our university.

This study illustrates the potential of re-imagining and re/forming pre-service programs to incorporate practica experiences that go beyond classroom settings. It provides evidence of the value of expanding our vision for teacher education and illustrates a strategy that may help teacher educators “to prepare teachers who believe in and know how to provide challenging learning opportunities for all students” (Cochran-Smith, 2005, p 15).

## Notes

1. The Vancouver Aquarium Marine Science Centre is located in the City of Vancouver, BC, Canada, and is dedicated to effecting the conservation of aquatic life through display and interpretation, education, research, and direct action. The Aquarium is home to 60,000 aquatic creatures, comprised of 800 different species. Each year 80,000 school children learn about aquatic life through our school programs.
2. In this paper we use the term museum to mean institutions such as aquaria, science centres, natural history museums, botanic gardens, and nature centres.
3. In this study classrooms were arranged according to alternative pedagogies, emphasizing students' active role in learning, inquiry and collaboration.

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