

Educating Science Teachers for the Sociocultural Diversity of Urban Schools

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Abstract

This interpretive study of the preparation of science teachers for urban high schools explored the extent to which learning to teach was facilitated by the methods courses, cooperating teachers and university supervisors. Because the methods course was minimally effective in addressing the needs of teaching low track students from conditions of poverty the methods instructor, Tobin, decided to be a teacher-researcher with such students. He joined Smith, a student teacher and Seiler, a doctoral student, in an investigation that examined learning to teach in a graduate teacher preparation program. In an endeavour to gain a first hand grasp on the challenges of teaching African American students placed in a low track program of study the three authors of this paper co-taught science in an urban high school. The paper incorporates rich perspectives gained from the teacher-researchers and theoretical frameworks associated with resistance, habitus and learning to teach by co-teaching. The paper advocates co-teaching as an essential component of teacher education programs.

Introduction

In the conflict between theory and practice that the college and school site represent, teacher preparation belongs more in the domain of theory and the purview of the college. As many public school teachers acknowledge when they return to college for additional coursework, the ivory tower does isolate its inhabitants, but it can give them a perspective that is restorative in its idealism. Prospective teachers, especially those who will work with poor, minority students under conditions that reinforce failure, need to have the "ideal," which they see little of in urban schools, emphasised in their preparation, to gird them against the "real," which they see and hear far too much of when they teach. (Weiner, 1993, p. 133).

The citation from Weiner is problematic even though there are elements of common sense in what she asserts. Unless student teachers learn to teach in urban schools how can they expect to know how to teach in such settings when they graduate and seek employment? We regard knowledge of teaching as something that is enacted. What can be written and spoken about essentially have a different character than knowledge of teaching. Being able to write about how to teach in urban schools or having read key theoretical and empirical works about teaching and learning in urban schools are no guarantee that a prospective teacher will teach successfully. Furthermore, learning to teach in a suburban or high track class may not provide the experience from which a person can learn to teach students from low track classes. We regard field experiences in a variety of urban placements as essential in the process of learning to teach in urban schools as well as experiencing alternative images of what is possible in the best schools and deep exposure to theories that can enlighten those experiences. The link between theory and practice has been a site for dispute for as long as there have been teacher education programs. Now there is a need to move to a deeper level in the debate. While it is easy to assert that there

ought to be a seamless connection between theory and practice, it is quite difficult to accomplish that connection in ways perceived by stakeholders as having worked.

It has been more than 10 weeks since I took over the responsibility for the first period class in the Opportunity Center¹ of an urban high school. In that time I have tried so many things and most of them fall short of what I expect. I adapt and always try to lift the bar on my expectations. Ever so slowly I am learning how to cope with the class, finding ways for my extensive knowledge of teaching to make a difference to the learning of my students. From my perspective there is no real rush to be successful because I have made a four-year commitment to learn to teach students like these. But to say that I am challenged may be the greatest understatement I have ever made. My habitus of teaching and self-identity as teacher have been shaken as I realise that years of teaching elsewhere did not prepare me for these learners and these contexts. Also, my reading of the literature in urban education, including Lois Weiner's book on *Preparing Teachers for Urban Schools*, only alerted me to some of the critical issues. I was not ready to teach these students when the regular classroom teacher completed some instructions to a restless class, glanced at me, and with a gesture of his hand said: "Dr. Tobin ..." From that moment, it seems, I was on my own.

The initial class wasn't so bad because I had a lab planned and the students enjoyed the chance to engage in a new way. But when I came in with a follow-up lab the next day I was surprised by the resistance to engage in serious inquiry. From then on the struggle has continued in earnest as I have learned what it means to say "these students need structure." Telling me about the issues, or reading about them, would have been of little value. In fact each day when I come to class I learn in a deeper way what it means to provide structure for a class that consists of African American students, mainly from homes characterised by poverty and instability, and with chronic patterns of failure and irregular attendance. At times I have to struggle alone and at other times I am able to step back and watch the classroom teacher try different approaches. I am fortunate too in having Gale and Mac there to co-teach with me. As the weeks go by the magnitude of the struggle is becoming comprehensible. The romance of what I am doing has long passed and the grit and grind of teaching in the Opportunity Center for upward of three hours a day is becoming routine. (Ken)

Ken's experience with the high school class from Opportunity has focused our attention of structure and open-ended activities. Ken experienced considerable resistance to his relative lack of structure to scaffold his students in their problem solving tasks. What he failed to realise initially was that middle class students, with whom he has had most experience, build their own structure for engaging in tasks that are inherently ambiguous and that require understandings to be built from arguments about relationships between knowledge claims and data. Whereas middle class students tend to provide their own structure in such activities (or some of them can be central participants in activities that require such structure), most of the students in Ken's chemistry class were unable to participate in the activities he prescribed without considerably more scaffolding from him. Through his experiences of working with students to get them actively engaged he has come to know what resources are needed by his students if they are to accomplish goals pertaining to inquiry and problem solving.

Throughout this paper we make the case for an approach to science teacher education that is essentially field based, where learning to teach is based on teaching and learning from what happens in the field. We provide some insights into the challenges of learning to teach science in urban schools and offer some suggestions for change that will frame what we do in our own science teacher education program in the near future. The paper describes research on the teaching and learning of science in urban schools, undertaken by a research team consisting of the authors of the paper, a student from Opportunity at City High School (CHS), and the classroom teacher

in this study, here referred to as Mr. Spiegel (a pseudonym). We have written the paper so that each author has a voice to reflect perspectives associated with his or her differing experiences as teachers and in his/her lifeworld. Where the voices are not identified as being one author what is written represents the collective voice of the authors.

Teaching as Experience/Practice

Epistemologies grounded in phenomenology include a variety of disciplines, all of which regard being in the world as a pre-condition for coming to know.² Accordingly, as we think about learning to teach it is critical to ask about the nature of the worlds we inhabit. Weiner casts the issue in terms of theory and practice, a dichotomy that others have endeavoured to bring together in a variety of ways that have included the use of professional development schools (Ebert, 1997; Levine, 1997). While it is relatively easy to exhort teacher educators to bridge the gaps between the university and the field experiences it is quite another to have the tools to think about how to do this effectively when things do not work out as planned.

Bourdieu's (1992) theories of habitus and cultural capital are salient to the project of learning to teach. According to Roth and Tobin (1999), "Habitus generates, without reflection, the patterned ways we interact with the world, that is, our practices which embody both actions and perceptions."

Through my many years of being a science teacher I developed a habitus that generates the practices I enact in my present research. Similarly, as a result of being in their lifeworlds and schools, the students I teach also have generated habitus that pertains to their being in science classrooms. However, teaching is most difficult because my habitus generates practices that do not fit well with their practices and the habitus that generates them. At issue is how coparticipation in the same classroom can lead to the development of a new habitus that applies to the communities associated with the teaching and learning of science. What forms of science learning will the habitus support, what curricular activities emerge as conducive to the learning of the students, and what are the optimal roles of teachers and students? (Ken)

Teaching is something that is done. Thus, when individuals speak about teaching they are speaking about re-constructions of teaching and the knowledge of teaching is not the object of their discussions and reflective analyses. However, while teaching, a teacher knows and does in the presence of others within a community (Roth, 1998a, 1998b; Tobin, 1998a). The interactions that occur constrain the knowledge in action and adaptations occur in ways that are reflexive and spontaneous—constrained by the actions of others in the community. As co-participation occurs the knowledge of teachers and students is adapted and mediated by the sets of interactions that occur (Tobin, 1998a). In addition, the habitus (Bourdieu, 1992), that cultural fabric that saturates all interactions but "exists" beyond consciousness and language, also is an integral part of what teachers know and can do.

In the act of teaching, a teacher's habitus generates practices as part of enacting a curriculum: as such, the teacher interacts with learners and the artifacts that serve as resources to support learning. The habitus frames teaching without conscious thought and to the extent that the curriculum is enacted smoothly there is little conscious thought about the various components of teaching. Only when the habitus of the teacher does not fit with the habitus of the students is there a need for deliberation and change. At this time a teacher can become conscious of the components of his/her habitus and identify parts that are working and those that are not. Through

reflection and subsequent action it is possible to generate a new habitus that may be better adapted to the milieu in which teaching is to occur.

Because of the complex faces of teacher knowledge it is important that prospective teachers be given opportunities to learn to teach science by teaching science. An obvious way that has been tried and tested for as long as there has been teacher education is to place student teachers in classrooms and allow them to teach a whole class alone for a sequence of lessons. Student teaching has been structured to allow this to happen for a long time. However, another important way to learn to teach is to teach alongside others who are teaching (Roth, Masciotra, & Boyd, 1999). In this way a person not only learns by doing but also has opportunities to experience teaching of others as it is done in a co-participatory way. Because co-teaching individuals see the classroom from the same vantage point, they truly share their experiences. The shared experiences associated with co-teaching are then starting points for conversations about practice, discussions about events and issues associated with practice and the reflective possibilities for future teaching episodes. Co-teaching enables student teachers to experience relative success and failure while teaching in the same space as another. The other teacher can be another student teacher, a cooperating teacher, a methods instructor or a college supervisor. Recently our teacher education program has begun to arrange for co-teaching to occur, not only at the beginning of a student teaching assignment but throughout that experience so that a person learning to teach has opportunities to "become like the other" through co-participation. Although co-teaching situations create opportunities for reflective discussions after the teaching has occurred, they also are sites for learning through co-participation those aspects of teaching that are beyond language. What is salient in this learning situation is that the knowledge of teaching, as it is enacted, is adapted in situ—as distinct from the reconstructed knowledge that is adapted during reflective analyses that occur after teaching has occurred.

Cultural Capital and Standards

Cultural capital concerns resources held to be desirable, beneficial, and possessing a high measure of integral worth. These include social behaviour, language, commonly held values, ethics, moral codes and socially ratified goals, aspirations and beliefs, and other factors that combine to facilitate the formation of a cohesive, recognised group cultural identity. Thus what a student knows and can do are sources of capital on which subsequent learning can build or a means of navigating a community in the quest to attain given goals. Bourdieu (1992) contends that students from upper-middle and upper-class families possess a cultural advantage in terms of success that lower-class students do not, because schools tend to reward those who demonstrate knowledge and appreciation of upper-middle and upper-class culture. Research on social class suggests that the upper-middle class model of success is the cultural norm for all students and that schools devalue students who deviate from expected patterns of behaviour (Rothstein, 1993).

There is a tendency for the primary discourses of children from homes of working class or unemployed not to connect well to a scientific discourse (Atwater, 1996). Accordingly, teachers enact the curriculum for such students to emphasise the learning of scientific facts and to de-emphasise conceptual learning, inquiry and scientific habits of mind (Anyon, 1981). Because school science typically reflects white, middle-class experiences (e.g., Lemke, 1990), and might have little relevance to the lives of students in poverty, there is a risk that school science simply maintains the status quo and pushes these students even further toward the margins. Because students from circumstances of poverty may enter school science with experiences or language uses that are different from what schools or science legitimate, there is a high priority for teachers

to make explicit the rules for participation in school science. Ken's experience with lack of structure was a clear example of this necessity.

The National Science Education Standards (National Research Council, 1996) recognise equity as an essential goal and place the responsibility for providing equitable access to science education on "all those involved with the science education system" (p. 2). However, as Rodriguez (1997) points out, the standards do not directly address "the ethnic, socioeconomic, gender and theoretical issues that afflict science education..." (p. 19). Barton (1998a) also has addressed the issue of science for all, especially in a context of students in poverty. She concluded that a major obstacle to accomplishing science for all is a tendency to regard science as a central, static discourse. Instead, she argues for a reflexive relationship between science and all, a relationship in which both can move. This way of thinking about science leads to a situation in which science knowledge is perceived as connected to the learners and their lived experiences. In a context of wanting all students to attain high standards of science achievement it is critical to consider the habitus that each student brings to school and the cultural capital that can be used as a foundation for high level attainment. To the extent that habitus and cultural capital of students reflect their everyday lifeworlds, including social class, the nature of the science education that is most appropriate for them may relate to such factors. Considerations such as these render as problematic the notion that one set of Standards in science education can meet the goals and needs of all Americans.

Preparing Teachers to Meet the Challenges of Urban Schools

The evidence from research accords with common sense in that a lack of educational resources in urban schools contributes to the failure of students in poverty to perform at acceptable levels (e.g., Diver-Stammes, 1995). Students in poverty tend to attend schools that use outdated textbooks, have minimal laboratory equipment, and have limited science club participation or provision for after-hours science. In addition, for students in poverty, participation is restricted in summer camps, poorly qualified teachers tend to be assigned to their schools, and science education is not perceived as a priority. Although Kahle and Meece (1994) noted that the science achievement of females and minorities is enhanced when students have access to resources such as hands-on laboratories, field trips and role models, Barton (1998b) indicated that factors associated with the performance of students in poverty extend beyond the availability and use of such resources. Barton commented that:

If children in poverty are to participate in a science for all program in genuine ways, then their education must be viewed as something more than access to laboratory resources and certified teachers, although these are important and, sadly enough, often overlooked. (p. 539)

What is the most appropriate way to think about learning to teach science in urban schools? To what extent is it possible to take knowledge that has been built from oral and written texts and transform it into classroom actions? We believe that at least some of what is learned in this way can be enacted. Accordingly, it is important to include courses that provide opportunities to learn from oral and written texts as part of the ongoing program of study for prospective teachers. It seems highly desirable for such courses to be closely aligned with field experiences. Also, it is important for discussions between the student teacher and others to be scheduled so that what happened in field experiences can be described in narrative and propositional forms thereby creating objects for reflection, around which interaction can occur. However, most of what can be learned and applied in classroom contexts can be appropriated while teaching. Learning by

doing assumes an epistemology of practice (Roth, 1998a, 1998b). As teaching is practised knowledge is constructed in ways about which the actor is not necessarily conscious. So, it is essential that a teacher education program allow student teachers to teach in a variety of contexts in which they can learn to teach by doing. At least some of these should include the teaching of full classes as they go about their "normal" curriculum. One way to do this is to place teachers in front of the class and let them teach. Of course this will allow the teacher to experience in unique ways and learn by interacting with students in ways that reflect their developing knowledge, values and beliefs. In some regards this can be considered as a traditional approach to teacher education. The prospective teacher is placed in normal or real situations and learns to teach by trying and making changes to accord with feedback from a variety of sources. An addition to this approach is one that assumes that prospective teachers can learn from others by teaching at their elbows. One decided advantage of doing this is that co-participation is possible as multiple teachers and learners interact to maximise learning.

We are most impressed with the recent research on co-teaching. Michael Roth has shown clearly that his student teachers can learn from him and he can learn from them (Roth, 1998a, 1998b; Roth, Bowen, Boyd, & Boutonné, 1998; Roth, Masciotra, & Boyd, 1999). However, learning from Roth is not all that analogous to what might happen when we assign student teachers to the schools in West Philadelphia. Many of the teachers in these schools struggle as they enact the curriculum and endeavour to facilitate the learning of students with sporadic attendance, wavering motivation to learn and, in some cases, tendencies to be extremely disruptive. The regular teachers endeavour to be successful as often as they can and it is very difficult indeed to identify teachers who attain success on a regular basis. Those who are successful usually call on all of their personal resources to attain the level of success that occurs. Must the supervising teacher be an expert or is it possible for learning to occur from less successful participants in the teaching profession?

The need to prepare teachers for urban settings is a challenge for us. Where should the student teachers do their student teaching? If we place them with a strong teacher who is able to teach effectively they will inherit a classroom that is functioning effectively and that can support a style of teaching that is similar to that of the regular teacher. For the most part the students will continue with their established roles and abide by the mores of the classroom culture. The influence of the classroom teacher will continue and, although students may put the student teacher to the test, the problem repertoire that is encountered is constrained by the established culture of the classroom. It is relatively easy to learn to teach in circumstances such as these and student teachers who are placed with effective cooperating teachers usually learn quickly to teach effectively in the situations they encounter. However, we are not sure that they can then teach in contexts in which a similar type of culture has not been established.

Context

Philadelphia has the fifth largest school district in the nation. Because of its size the school district is divided into 22 clusters, organised around neighbourhood schools, each with its own administrative office. Enactment of a policy to create small learning communities (SLCs) produces schools within schools, each containing up to 400 students. The idea is to allow students to experience a small school and thereby to create a feeling of family, belonging, school loyalty and shared values. CHS, where this study was conducted, is an urban high school in Philadelphia with an enrolment of more than 2,000 students, 98% of whom are African American and from conditions of poverty.

The application of the SLC policy has resulted in 10 small schools within CHS. Each SLC has one science teacher who remains with the students for their four years of high school. The enactment of the SLC policy has markedly changed the dynamics of the school, which is now safer with fewer major fights and disruptions. It also is possible to focus the curriculum to a greater extent on the needs and interests of students. However, the SLC policy also may have introduced some inadvertent disadvantages. Our research in Opportunity suggests that the difficulty of teaching and learning of science are increased for the lower achieving students by pervasive tracking of students (Oakes, 1985; Page, 1991), limited resources to support learning, and inexperienced (and sometimes ineffective) faculty. Essential resources such as equipment and supplies and access to the Internet are more limited in Opportunity and there is a tendency for the more experienced faculty to transfer to the more academic SLCs or to other schools.

Method

The study commenced in the Fall of 1998 when Mackenzie (Mac) was assigned to CHS to undertake his year-long field experience as a component of a master of science in education degree that would lead to certification to teach science. Ken, his methods lecturer, and Gale, a doctoral student in science education and an experienced urban science teacher, visited Mac and each of the science education students to investigate how they were teaching. Our concern was that the methods course and the field should support one another seamlessly to enhance the learning of how to teach science. A critical focus of the study was to probe the roles of the methods instructor, cooperating teacher, supervisor and student teacher in relation to the goal of learning to teach science.

The data sources for the study were field notes, narratives written after our experiences in the field, digital photographs in interviews of student teachers, cooperating teachers and supervisors and artefacts collected from the field. A computer application, *Connecting Communities of Learners* (CCL, Tobin, 1998b) was used in the methods course by all of the science education students. The CCL allowed all students to write about their experiences in their student teaching, methods course and other courses. The CCL provided a space in which students could interact publicly or privately. All of these written comments were available to inform our learning and the writing of this paper.

In the spring semester Ken decided to co-teach in Opportunity, where Mac was doing his student teaching. Our reason for selecting Opportunity was because of the extreme difficulty Mac was experiencing in attaining his goals as a learner and the relative inexperience of his cooperating teacher. Ken was well aware that teaching in circumstances like those in which Mac was learning to teach involved some danger. In all likelihood what was happening in the methods course would be of little or no relevance to what Mac and others needed to know in order to be successful teachers. Ken's dilemma was what to add in place of the present activities.

When the co-teaching commenced the variety of data sources available to inform the study mushroomed. Ken and Mac were at the school daily, Mac all day and Ken for three hours (first and fourth periods). Gale came to the school several times a week and usually stayed for at least the first two periods. On occasion we videotaped lessons and interviewed students to obtain their perspectives on teaching and learning science, being in Opportunity and the extent to which the home and community supported learning. During the spring semester a student from Opportunity joined the research team and his insights were of considerable value in assisting us to understand what was happening in our various experiences as teacher-researchers.

The analysis and interpretation was continuous over the duration of the study. The writing of this paper began with several earlier papers written by Tobin (1999 a, b) and Seiler (1999). In these papers we had identified the most salient issues pertaining to science teacher education in the urban settings in which our prospective teachers were being prepared to teach. The three authors met and decided that we would each write some comments pertaining to the methods course and the roles of the cooperating teacher and supervisor respectively. Two weeks later when we were due to meet to discuss these perspectives we decided to begin with Mac's perspectives and engage in a three-way professional conversation about those. Our goals were to develop a discourse from which we could learn, identify salient theoretical issues, and initiate a variety of possibilities as foci for change. The approach had been used with success in research undertaken by Ken with Wolff-Michael Roth and Steve Ritchie (Roth, Tobin, & Ritchie, 1998) and with Peter Taylor and Penny Gilmer (Taylor, Gilmer, & Tobin, 1998). In a forthcoming book (Roth, Tobin, & Ritchie, 1999), Roth described metalogue in the following way:

A metalogue is a conversation about some problematic subject. But it is not just a conversation. Rather, in the ideal case, the structure of the conversation in its entirety is also relevant to the subject; that is, a metalogue exemplifies its subject matter in its form. Jacques Désautels also pointed out to me that metalogues have an evolutionary structure in that they constitute earlier parts as new conversational topics.³ Here we use metalogues in the way Mary Catherine Bateson⁴ constructed them, not as stand-alone texts but as conversations that occur in a context.

There is some agreement on the difficulties of bridging theory and practice in science teacher education and no consensus that we can see on the best way to do this. However, for the most part the trends in science teacher education have mirrored the shifts that have been evident in science education. From the 1970s to the present time the main shifts have reflected a growing tendency to view teaching, learning and teacher education through progressively richer theoretical frameworks (Tobin, 1999b). Many of the present approaches to teacher education emphasise social constructivism, reflective practice, and the development of teachers within communities of learners. Science also is recognised as a discourse community in which "Students should experience science as a process for extending understanding, not an unalterable truth" (American Association for the Advancement of Science, 1989, p. 187). The ways in which science is to be re-presented to students include the doing of science through the practice of inquiry, problem solving and participation in laboratories and hands-on activities. However, as Anyon (1981) showed so graphically in her classic study of social class and the enacted curriculum, there is a tendency for communities to fuel a cycle of social reproduction by enacting curricula that relate to the social class of the students. As Willis (1977) described, the curricula for students in the lower classes tend to create forms of production that reinforce disadvantage. Fine (1991) and Anyon (1997) provided many examples to illustrate how the cultural production of poor urban students feeds into a cycle of these students being unsuccessful at school and dropping out. Accordingly, a critical need for science teacher education programs that prepare science teachers to teach in urban high schools is to prepare them to teach in ways that are potentially transformative in that urban youth have social options relating to further study, employment and an improved standard of living. However, the studies of Yerrick (1998, 1999) provide a chilling reminder of the pervasive effects of social class and its manifestations in the enacted curricula for students in low track science classes, whether they be in urban or rural communities.

The key issues addressed in this paper emerged from two parallel studies of the teaching and learning of science in urban schools and preparing science teachers for urban schools respectively. The overriding problem that we faced was how to create a teacher education program to prepare teachers for the problems that arise in urban schools, particularly in classes involving low track

students. The paper addresses issues associated with the methods course, the cooperating teacher, and the university supervisor. In so doing several key concepts permeate the entire paper. The most significant of these are the role of habitus in teaching and learning science (Bourdieu, 1992; Roth & Tobin, 1999), resistance (Derrida, 1982; Newmann, 1992; Yerrick, 1998), co-teaching (Roth, 1998a, b; Roth & Boyd, 1999) as an approach to learning to teach that has potential, and social reproduction (Willis, 1977).

Methods Courses and Teaching

Mac: There really wasn't much of an emphasis on the teaching of a specific subject-area methods course in my education program. If you had asked me how I felt about this during the time when I was taking my science methods course, undoubtedly, I would have expressed a major concern to you. I remember the first day that Ken (my science methods instructor) began teaching a class in the same high school that I was student-teaching in. He came to the chemistry class that day with a very impressive chromatography activity where the students were to separate out the mixture of colours found in common marking pens. It was a great hands-on activity that can be used to teach the kids about several different important scientific concepts. I remember thinking to myself that day, "Why didn't he teach us that in our methods class?" One of the major problems that I have as a young teacher is coming up with creative lesson plans that utilise the educational philosophies that we have been taught. I would have definitely benefited from an intensive biology methods course though I realise that with the many different sciences and mathematics courses offered in high schools, it would be a very daunting task for a small education program to offer a methods class for each of these.

Gale: What do we mean by a methods course, and in particular, a science methods course? Should it include ideas on educational philosophy, teaching style, science resources, curriculum plans, lesson plans, and how much more?

Ken: Reading the literature is very important and the selection of what literature to read is of obvious significance. The challenge is to use your reading to build referents as guides for teaching.

Mac: The educational philosophies of Dewey, Glasgow, and Bruner that played such a major role in our coursework prior to our student teaching experiences definitely should be included in every education program-whether or not it specialises in urban education. Some of these methods, such as how to promote the ability to think critically and how to get your students to learn by doing, are tremendously important in an urban environment because those skills are horribly underdeveloped in the students who reside there.

Ken: For more than 25 years now I have been teaching methods courses off and on. The biggest challenge of all for me is to have my students appreciate a need for learning to think about teaching and learning in different ways. I think about methods courses in terms of the metaphor, teach me to fish, don't give me fish. But my students seem to want fish.

Gale: Mac seems to have found value in the philosophies of education he studied at the university, however when he walked to his high school, he entered a different pedagogical and epistemological world with classrooms where knowledge was conceptualised as something that can be transmitted. Mac expressed the desire to teach in a more constructivist manner but seemed at a loss to know how.

- Mac: Exactly. It's pretty hard to teach in a constructivist manner when you haven't witnessed it very much in your educational career. My own high school experiences were similar to my students' only in the way that the teachers transmitted the knowledge. And if any of my students from this year make it to a college program, I think that they will, for the most part, find that the teaching done there is still very traditional. Picking out the few constructivist teaching methods (and applying them to a class you are teaching) from the multitudes of non-constructivist teaching methods was a very daunting task for someone struggling with a host of different problems.
- Ken: Teaching is more than knowing theory and applying it (e.g., Roth, Lawless, & Tobin, 1999). My own view is that teaching is learned by doing it. And, I think that learning to teach is best accomplished by co-teaching with others. Observing can be of assistance because it gives a prospective teacher ideas about what to do. Similarly, reflecting on what has been done or experienced also can be a source of ideas. Reading and watching videos, writing and discussing are all activities that can lead to the generation of ideas about how to teach. Hence I think we should do all of these things in a methods course. But, at the bottom line, the teaching must be done. Hence I can see a methods course being planned entirely around co-teaching.
- Mac: I learned the most about teaching methods from observing other science teachers, especially the student science teachers. Without the countless hours spent observing, and sharing methodological ideas, I would have spent many more restless nights lying awake worrying about how I was going to help my students become better prepared for the world that they are going to enter in the very near future. Don't get me wrong, I did learn a lot in my science and math methods course, and I especially have learned a lot from watching Ken teach the students in my high school.
- Ken: I am not advocating only watching others. My suggestion is to co-teach and to learn by doing at the elbows of someone like me. Of course in a co-teaching situation I would expect to learn from you too. We can learn from one another not only from our successes but also from our failures.
- Gale: I recall that Mac went on and carried out a similar chromatography class activity with his own class a few days later. It seems that he was able to do this comfortably not because he had been "told" about how to do chromatography in a methods class, but because he had participated in the lesson along with Ken, Mr. Spiegel, and me. Following the participation, he was able to reflect on and adapt the activity, to personalise it for his class, his students, and his own teaching.
- Ken: There are many sources for learning to teach. These include your methods instructor, fellow prospective teachers, the college supervisor, and even your own K-12 students. I envision an approach to learning to teach by coparticipation in classrooms. Discussions about what happened, with those who co-participated can assist us all to better understand teaching and learning.

Student Teaching and the Role of the Cooperating Teacher

- Mac: I don't think that "cooperating teacher" (co-op) is a very good term for Mr. Spiegel. To me, "cooperating" means working together to develop my skills as an educator. This really hasn't happened very much in the past year. I have gleaned some valuable information from him, but as far as actually cultivating knowledge and developing the skills of my students, Spiegel hasn't really taught me very much. We never plan lessons together, teach

side by side, talk about educational goals for our students, or provide feedback on each other's successes and failures. To me, that would be the ideal relationship between student teacher and cooperating teacher.

Ken: I think it is an imperative for us to redefine the roles of cooperating and student teacher. So many aspects of the old model are less than desirable. I want to see the cooperating teacher involved in a range of co-planning and co-enacting roles. The issue for me comes down to the best way to experience knowledge of teaching and to learn to teach. I want to see more instances of two or more teachers teaching alongside of one another, each with her sleeves rolled up. Co-teaching allows for rich conversations about what happened and why each of the teachers did what she did.

Gale: It seems as if the old models die hard, however. The words of Mac and Mr. Spiegel echo with very different conceptions of what the cooperating teacher's role should be. We can understand a great deal from Mr. Spiegel's account of his own student teaching experience. Neither of his two co-ops provided an opportunity for a real examination of teaching and learning. The extent of their collaboration was exchanging notes and handouts, not dialogic, discussion, and joint development of lessons. So Mr. Spiegel himself seems to have been deprived of meaningful interactions with his co-ops. Perhaps the superficial exchanges with Mac are modelled after his own experiences. This lack of substantive communication seems to have hampered the learning of both participants.

Mac: Very early in the year, I realised that I did not want to be the type of teacher that Mr. Spiegel had become in his very young teaching career (two years). On the first day of my observation period, I realised that Mr. Spiegel expected very little of his students. What they learned definitely seemed to be ancillary to how they behaved. If they didn't cause problems, and they made an attempt to complete the assigned work, Mr. Spiegel gave them at minimum a passing grade.

Ken: The low expectations are supported by Spiegel and the students. We have found the students very resistant to lifting standards. Their actions in resisting are examples of social reproduction (Willis, 1977). They resist and the curriculum tends to be less useful because of their resistance.

Gale: There is a great deal to understand about the student resistance to learning that we find in this environment. The teachers and staff with whom I have spoken at this school attribute the poor student performance to deficiencies in the students' social and economic conditions, families, and culture. The low academic expectation is also reflected in the idea that even though a teacher does all she feels that she can do, only a few students will make it. The staff accepts the economic and social conditions as grounds for low expectations and therefore does not consider how to improve the students' experiences and academic performance. This belief puts the problem outside the school and beyond the realm of traditional teacher responsibility. It ignores the bigger problem, that the structure of the school is unfair and biased against the students. That the curriculum, discipline, and attendance policies, and the very atmosphere of the school is rigged against the students and fails to take into account their lived experiences.

Mac: I quickly learned that this was not a classroom that fostered the development of skills that a science classroom should develop. Nowhere did I see kids learning how to make observations or inferences, how to collect and analyse data, or how to approach a problem in a systematic manner—all skills that can help students become productive members of society whether or not they go into science! As a result, I resolved to raise the bar in this classroom. Expectations would be higher, and hopefully I would get a few students to follow me.

Gale: To place a student teacher into this SLC is putting her in a very difficult situation, where learning to "handle" the students often becomes secondary to science teaching.

Mac: At times, Spiegel's idea of his role of co-op and my idea of the same role didn't really mesh. One particular instance comes to mind. I was having a particularly difficult time controlling my class one day, and Mr. Spiegel intervened on my behalf. Unfortunately, I felt as if events like this were part of my learning experience and I wanted to try and diffuse the situation myself. The following is an excerpt from a posting on the CCL.

Everything I wanted to do took about three times as long as I wanted it to. When I finally got around to handing out the materials and getting them started, it was 10:15...19 minutes left in the period and they hadn't even started the experiments yet!!! I could tell that they weren't going to get anything done and so I told them to forget about it. I said, "If they didn't want to learn science by doing experiments and all they wanted to do was take notes that that's how I could teach them." I collected all the materials and had them sit and do nothing for the last 10 minutes of class.

At this point, Mr. Spiegel got up and yelled at them and told them how disappointed in them he was and that "Mr. Smith spent a lot of time trying to plan a fun activity for you guys and all you did was disrespect him ..."

I really appreciate Mr. Spiegel trying to stick up for me, but I feel like a little kid whose big brother comes around to kick the bully's butt for him. I feel as if any progress I've made with these kids has been lost and that now I'm back at square one, or even negative one.

Ken: If I had not been teaching in similar classes I would have shaken my head in sorrow. The expectations are depressingly low in the classes in which we have been teaching. In fact throughout the entire school they are low. But the students are as responsible for the low expectations as teachers like Spiegel. I have had tremendous resistance to teaching and it takes many hands to individualise the program for students such as these who have patterns of sporadic attendance and tend to disrupt the class frequently. Obviously we need to have the highest of expectations, but it takes more than one teacher to get the curriculum to where it ought to be.

Mac: Despite our problems this year, I am very grateful to Mr. Spiegel. He has taught me, albeit indirectly, many wonderful ways of dealing with the multitude of classroom management situations that arise in an urban setting. Never once did he point out ways in which I should handle possible situations, but by watching the way he handled them, I was able to borrow, modify, test, fail, retest, and in many cases succeed in defusing a possibly explosive situation.

Ken: You may be underestimating just how much you have learned from him.

Mac: Looking back on that day, I may have somewhat over reacted. I was upset that I had failed in teaching my students what I thought was a valuable lesson and jumped on Mr. Spiegel for coming to my rescue. I think that a better way to teach me about these kinds of situations would have been to debrief me on it after I had tried to solve the problem myself. It would have been a much better learning experience for me if I had been allowed to fail-learning from my failures on other occasions this year have really provided me with the most lasting impressions on how to teach.

Ken: When the two of you teach together there is great potential for developing habitus that is shaped by the presence of the other. In the future this habitus that was co-constructed may

be the foundation for your teaching. There is an irony in your report about Spiegel's intervention. He was co-teaching. In fact he did much the same thing this morning in my class. I was thankful that he did even though I would not have done what he did. One student was being disruptive within a context of many of them speaking aloud and hardly doing anything. Spiegel jumped to his feet and gave everyone an impromptu test. The 15 minutes it took them to do the test settled them down and provided the structure these students need. What I learned from his action is to start every period with more structure. I had them starting with a lab.

Gale: You both learned about class management from Mr. Spiegel in the most effective way, by co-participating. In order to feel his reason for reacting as he did you had to be participating in the class with him, and experiencing the anxiety of classroom chaos with him, but we must be careful to not adapt a method just because it works in the short run. Remembering that learning is a socio-cultural phenomenon, we need to consider the contributions of our actions to the community of learners we are trying to foster.

Mac: As I get ready to depart from my student teaching placement, I look back and realise that there have been many positives and negatives about the whole experience. Do I feel pedagogically prepared for my first teaching assignment? No. But do I feel emotionally prepared to handle almost every possible classroom management situation? The answer is definitely yes. As for Mr. Spiegel, I think he learned a lot this year too. Perhaps he may have even come out better than I did. After all, he already knew how to deal with classroom problems, and I think that this year he might have learned some pedagogical techniques from me. Perhaps he got the best of both worlds.

Gale: In the beginning, Mr. Spiegel expressed the view that the knowledge needed to be a teacher is relatively easy to acquire, and that a new teacher may have nearly all it takes right from the start. He did not appear to view becoming a teacher as a continual endeavour of learning. Perhaps as a result of teaching with Mac, we will find that he has altered this notion. It makes me wonder what can be done to foster this view of learning to teach in all participants in the student teaching experience.

Ken: A critical characteristic of a co-op teacher is to be a co-learner and a commitment to co-teaching as a way to learn about teaching. We cannot afford to have situations where the teacher simply hands over the reins and provides evaluations based on observations from the back of the room. As we consider the qualities of a good co-op it is important to also consider a context that includes the other sources of support for learning to teach, such as the supervisor and the methods course and its instructor.

Student Teaching and the Role of the Supervisor

Mac: Diana is the supervisor of a group of six student teachers. We all teach at the same high school. We had our first meeting very early in the first week of our student teaching careers. One of the things that I remember about the meeting was listening to the tremendous amount of structure that Diana wanted to add to a program that, until then, had truly lacked a skeleton.

Ken: The issue of structure is learner dependent. Some bring with them a habitus to support their teaching practices and others need considerable scaffolding from someone like a supervisor. It goes without saying that those who need the structure should get it from somewhere, a supervisor, co-op teacher, fellow student teacher, or a methods instructor.

- Gale: We return once again to the question of role, and to the idea of a community of learners. The supervisor as passive observer and evaluator is a role we need to move beyond. Only by participating with the classroom teacher and the student teacher can the supervisor experience being in that particular environment. In this way, the supervisor presents herself as a learner alongside the others and can contribute to the knowing and thinking of the group over time.
- Ken: Initially I think it is important to observe and defer all judgments. When you feel comfortable as an observer then it is a good idea to get up and begin to co-teach. At that stage the rich conversations about teaching can occur. I am not in favour of having observers make evaluations of teaching based only on observations and thorough notes. To the extent possible I would like to see all evaluations of teaching involve some co-teaching and rich conversations about what happens.
- Mac: Diana spends a lot of time watching us in the classroom. She has divided her observations into formal and informal observations-though from my point of view, they are no different. At the beginning of the year, I really hated having her come to my class and watch me. She would sit in the back of the room with her notebook and not say a word until the end of class. Sometimes, the class would notice her and it would be just another distraction that they would use to their advantage.
- Ken: I worry about the validity of whatever advice she may give if her role is confined to the notepad and a seat on the side.
- Mac: As time moved on, and as our relationship developed to the point that we were more comfortable around each other, Diana stopped being a passive observer and became a very active participant in my classes. She seized the opportunities to interact with my students as well as to learn some science from me. The times that Diana spent in my classroom at the end of the year were much more comfortable, helpful, and informative for me than those times at the beginning.
- Ken: It would be my hope that you would build habitus through co-participating with Diana. However, the model seems to have been that of reflective practitioner.
- Mac: Yes. The times that I learned the most from Diana definitely occurred during the private meetings that we had after an observation period. We would frequently talk for periods greater than an hour. Diana would go through her notebook and comment on each and every note that she took. She would provide a lot of positive feedback on my teaching style and she constantly boosted my confidence. I can remember one time we met just after I had filled out a lengthy self-evaluation form where I marked myself average or below average on several items. Diana went through each of the items and pointed out to me that I really wasn't below average on any of them, and on most, I was at least average. She gave me a great pep talk, said that I was too hard on myself, and told me that the science being taught in my classroom was more science than she had ever seen at the school. Needless to say, this really helped me with my confidence in the classroom and provided me with a very helpful view of an outsider on my teaching ability.
- Gale: From what I have seen, the supervisor's involvement increases throughout the year. While this progression is understandable in terms of developing a relationship with the student teacher, it seems to not be responsive to emergent needs. The supervisor can play an invaluable role in facilitating the relationship and interactions between the student teacher and the co-op, and in many cases this is needed early on.

Ken: This is an important point. Discussion about shared experiences can lead to the emergence of lots of ideas to try.

Mac: Diana's duties extended far beyond the observation of her six student teachers. She also was responsible for weekly "on-site" meetings where we discussed various educational issues, each other's classes, and generally let off steam about the program, our students, and our co-ops. She also arranged for visits to other high schools in the area—one urban public school, and one urban private school. These visits proved very helpful to us because we were able to see that many of the problems we were encountering in our classrooms spanned race and class barriers.

What Have We Learned?

This study has highlighted several critical dilemmas that face teacher education programs in urban settings and others that are somewhat more pervasive. The nature and relative value of the methods course is a perennial problem for science teacher educators that is often characterised in casual lamentations of teachers to the effect that they did not learn much of value from their methods courses. One way to characterise the problems we experienced with the methods course this semester is that so much of it involved talk and words, albeit in a context of ongoing daily student teaching experiences. This is one way to come to know about teaching and learning and to access new ideas. However, the knowledge needed to teach is of a different genre than what can be spoken and written. Teaching is enacted and is best learned by doing in ways that close the theory-practice gap that has been a concern of teacher educators for so long (Roth, 1998a, 1998b; Roth, Lawless, & Tobin, 1999). Throughout the paper there are allusions to this principle and it certainly has been our experience that in co-teaching we all had opportunities to try out different approaches to the teaching of science in urban settings. Some of what we have tried worked well and most did not. For example, Ken's efforts to implement inquiry-oriented science were far too open and unstructured for the students in the high school class in which Mac was student teaching. His efforts to implement group work with Mac was initially successful but gradually became less so as the semester progressed. Efforts to enact materials-oriented activities also were not as successful as envisioned because the students had not yet built the discursive resources needed to construct science from hands-on activities. The problems extended beyond coordinating claims with evidence. At the heart of the problems were the students' perceptions of themselves as learners and their roles in relation to the teachers and activities. They expected to be told what to learn and to reproduce truths on tests of achievement.⁵ The students did not deal well with the uncertainty and associated ambiguity of inquiry and the necessity of creating their own structure to undertake longitudinal investigations. Learning how to deal with problems such as these involved us being in the class, with others with whom we could identify the problems by speaking about them and then raising alternatives to try when next we taught. These co-teaching experiences provided a rich resource for conversations that led to the emergence of a professional discourse for teaching science in Opportunity.

Though a title of this article might read "Experienced teacher/university educator plunges into teaching in a difficult urban setting," the real story is what was learned from being a part of the experience. Co-teaching in this high school, co-experiencing this place in time and space together, changed the student teacher, the classroom teacher and the university professor. Mac saw his methods class instructor struggling with a habitus that did not fit and realised that even after many years of teaching, one is still a learner. Ken saw how much more potent it was to teach

side-by-side in the setting where the student teachers are placed. One can not observe a habitus, one must experience it, if one wants to know it.

The value of co-teaching and co-learning is clear. Mac recognised it when he spoke of how much he learned from his fellow preservice teachers. It would seem that the teacher education program could better prepare teachers if it could tap into the possibilities of what happens when people teach together. This community of practice can include several student teachers, a classroom teacher, a university teacher, a university supervisor, and perhaps even other school personnel such as a lab assistant, or another non-teaching assistant. In this way, the presence of student teachers in the local public school can be catalytic. Their presence, and the development of a community of practice around them, has the potential to be transformative.

Much can be learned from the year spent with Mac. The personal attention that seems to be guaranteed by the assignment of one student teacher to one cooperating teacher is not always what is needed by a particular student teacher. Student teachers may derive greater benefit and growth from exposure to a variety of co-ops and teachers. Sometimes fruitful relationships do not grow within the school setting. The heightened involvement of the university mentor and other student teachers may serve to foster mutually beneficial interactions. In urban schools, we may not have the luxury of hand-picking cooperating teachers. They alone can not be expected to shoulder the responsibility for the learning of a beginning teacher in this difficult environment. The student teacher program as a whole can offer them support in their collaboration with the student teacher as well as in their own growth as teachers.

The issue of whether or not Mr. Spiegel is a good cooperating teacher is one that should never arise. We prefer to ask instead about how to structure student teaching experiences such that Mac and others can learn from teachers like Mr. Spiegel. Each of us has co-taught in the same classroom and can attest to things that we have learned from one another. What is unreasonable is to set up an expectation that Spiegel or any co-op teacher can teach a student teacher everything or even most of what there is to know about teaching. In co-teaching one can learn not only by seeing exemplary practice, but also by seeing failed attempts and practices that work but cannot be condoned. Learning to teach in the presence of teaching others affords opportunities to build increasingly expert knowledge. It is also possible to take risks because the scaffolds provided by others can allow a teacher to fade if a particular strategy does not work as intended. If several teachers co-teach in the same classroom it is possible for any one of them to move into the centre and fade without losing face. Of course if this is to occur the students must construct all teachers as resources for their learning. Trust and respect are as important in co-teaching settings as in the more conventional settings of one teacher teaching a class.

If co-participation is the heart of learning to teach then it is an imperative that the roles of all resources (such as methods course, cooperating teachers and supervisors) be structured such that all participants can interact in ways that make teaching visible in ways that can be accessed and appropriated. Co-teaching is one way of achieving this goal.

Where Do We Go From Here?

Emerging from this study is a model of science teacher education that assigns many student teachers to many practising teachers. For example, four student teachers may be assigned to four science teachers at the one school. Initially the students would observe together and gradually begin to co-teach with one of the teachers. As they begin to know the students and the program their roles as co-teachers can become more central. All aspects of learning to teach science would emerge from the experiences in the field. Hence, the group of four student teachers would plan,

enact and assess as part of a team that would include the practising teachers, the methods instructor and the supervisor. On some occasions student teachers could observe one another teach and perhaps create video-ethnographies to be used in subsequent reflections on action. The blurring of the boundaries between methods courses and field experiences allows a block of three hours that might ordinarily have been assigned to a methods course to be distributed for an hour a day for three days. In our case the methods course in the fall semester would be linked to the field experience that meets each morning for three hours. Reflective discussions and work sessions for three days a week could augment the discussions that occur between the student teacher and the co-op and supervisor. In all cases the discussions would be based on shared experiences.

Logistically the question that arises is whether the same individual can deal with the methods instruction and supervision. In our case in this study a conflation of roles was relatively easy since Ken and Gale were involved as researchers. Mac, who was student teaching became a co-researcher in the study and in the fall semester Spiegel and Diana undertook conventional roles as co-op teacher and supervisor respectively. In the spring, when our presence in the classroom was intensive, the role of Spiegel changed significantly because there always was more than one experienced teacher on whom Mac could rely to discuss his teaching.

As the student teachers build their knowledge of teaching and their confidence it is increasingly desirable for them to co-teach in pairs so that they can learn by working at one another's elbows. Although we do not rule out the value of having the cooperating teacher co-participate in this way, we are taken by some of the successes we have experienced in our program when this occurs. We mention this option here so that it receives due attention as a viable way to teach. At the bottom line we advocate the use of co-teaching to include two or more teachers teaching the one class, possibly with others watching and recording what is happening.

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Notes

1. The Opportunity Center consists of 230 African American students who are returning to an urban high school after extended absences or who have difficulties in adjusting to school. My experience is that once a student is assigned to the Opportunity Center it is almost impossible to leave. Hereafter we refer to the Center as Opportunity.
2. According to Roth and Tobin (1999) these include philosophy (Merleau-Ponty, 1992; Ricoeur, 1992), sociology (Bourdieu, 1997), anthropology (Lave, 1988), cognitive science (Varela, 1995), artificial intelligence (Agre & Horswill, 1997), and ethnomethodology (Sharrock & Button, 1991).
3. Roth & Désautels, in press.
4. See Bateson (1980) and Bateson & Bateson (1987).
5. It is ironic that students regarded objective and standardised tests as valued measures of performance since they are sources of social reproduction that tend to retain students like those from Opportunity in a fixed low social stratum.

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