CHAPTER II
LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

In the first part of this chapter I attempt to provide a detailed picture of the current scenario of urban science education in order to position my study. I describe the profound inequalities embedded in American educational system and how they play out in students' science learning. I continue to argue that good teachers can make a difference in providing urban youth in poverty with meaningful opportunities to learn science. I also talk about the high rate of teacher attrition in urban schools and about how some teachers who remain start to comply with the so-called "pedagogy of poverty" (Haberman, 1991, p. 290).

Drawing on many voices in urban education, I argue for the need of a specialized preparation for urban science teachers that supports them in enacting socially just science pedagogies. I discuss some of the main challenges that urban teachers need to cope with to be successful in urban schools. I continue to suggest the importance of field-based experiences that engage future teachers in collaborative communities. I finally describe some examples of prior efforts in using action research in urban teacher education.

In the second part of this chapter, I present the conceptual framework I bring to my study. I describe the social justice perspective that guides both my views on teaching and the analysis of my findings. I continue to discuss how sociocultural views on teacher learning informed my analysis of fellows' process of

learning to teach. I finally explain the ways in which the perspectives of critical pedagogy allowed me to examine the process by which fellows were able to coauthor novel spaces of participation –which I define as "hybrid spaces"- in their partner classrooms.

Literature review

Urban science education and the demographic imperative

Urban children and poverty

Relentlessly and some would claim that inexorably, our world is becoming an urban world. According to a 1999 United Nations report, while at the beginning of the twentieth century only 1 in 10 people lived in towns, by the mid-1990s almost 3 billion people -half of the planet population- lived in urban centers. The U.S. Census Bureau (2001a) indicates that, for the first time in history, nearly 80% of the United States population resides in urban centers, and that the numbers keep growing. The trends are similar in the developing world, with the emergence of megacities housing nearly half of the developing world population (United Nations Development Programme, 1999). The importance of urban education, therefore, cannot be overstated. As Angela Calabrese Barton and Ken Tobin (2001) have pointed out, now, more than ever in our global history, our children are living and learning in urban areas.

In many countries, urban areas bring together people from a variety of

origins. In the United States, for instance, the majority of the nation's ethnic, racial and linguistic minorities live in the nation's largest 20 cities. In New York City, the largest city in the U. S., the minority population reaches 57 % (U.S. Census Bureau, 2001b). Urban centers are also the home to immigrant families. In 2001, about 1 of 10 residents of the U.S. was foreign born, with the majority of immigrant residents living in large urban centers like New York City (Lollock, 2001). As these and other numbers show, the majority of American children are urban children. And the majority of urban children are minority children.

Among the key factors that shape urban children's lives in the United States and many other countries, poverty is one of the most prevalent ones. Statistics show that almost 17% of all students in the U. S. live in poverty. However, in many urban areas like New York City, Los Angeles, Detroit and Atlanta, this percentage ranges from 35 to 45 % (National Center for Educational Statistics [NCES], 2002). In New York City, the percentage of students eligible for free or reduced lunch is 73.3% - much higher that the 43.2% in the rest of New York state (CGCS, March 2004). Along these lines, urban centers globally confront many adverse conditions usually associated with poverty such as a lack of open space, crowding, discriminatory housing and schooling practices, high crime levels, environmental pollution and ecological degradation (Calabrese Barton & Tobin, 2001).

Among urban minorities, Latino and African American families are overrepresented in poverty statistics. In 2001, the urban poverty rate for African Americans was 22.7% and 21.4% for Latinos, more than twice than the 9.9% for

Whites (U.S. Census Bureau, 2001b). Along these lines, more than 40% of all urban students attend high poverty schools. Not surprisingly, those schools serve a vast majority of students of color, predominantly of African American and Latino backgrounds (Ladson-Billings, 1999).

The demographic imperative

The phrase *demographic imperative* has been used to make the case that society must take action to alter the disparities in opportunities and outcomes deeply embedded in the American educational system (Banks *et al.*, 2005). As Haycock (2000) has argued, "just under the surface is a system that, despite its stated goal of high achievement for all children, is rigged to produce high achievement in some kinds of children and undermine it in others" (cited in Zeichner, 2003, p. 493).

Just a brief look at educational statistics is enough to reveal the big achievement gap between urban children living in poverty and children from more affluent communities, as revealed through test scores. Statistics show that at grades 4 and 8, students in central city locations have lower average scores than students in urban fringe/large town and rural/small town locations (NCES, 1999).

In science, a comparative look at the proficiency of thirteen year olds from 1970 to 1996 is a compelling indicator of the achievement gap that has persistently existed over two decades. Statistics reveal that, consistently, White students were more proficient in science than African American and Latino children, that

students whose parents attended college were more proficient than students whose parents did not and, finally, that students from private schools were more proficient than students from public schools (NCES, 2003b). And the trend does not seem to recede. The 2000 National Assessment for Educational Progress (NAEP) reported that 8th grade students who were eligible for the free/reduced lunch program obtained lower science scores in 2000 than in 1996, while the average score for students who were not eligible for reduced meals increased during the same period.

In his reanalysis of the Third International Mathematics and Science Study (TIMSS) data, Berliner (2001) exposed how "in science … the scores of white students in the United States were exceeded by only three other nations. But black American school children were beaten by every single nation, and Latino kids were beaten by all but two nations" (p. B3). Along these lines, the 2005 NAEP showed that, in New York City, 73 % of Hispanics and 77 % of Black students scored below average on eight grade science exams (Schemo, 2006).

These numbers are not surprising when we look at other statistics that evidence students' differential access to qualified teachers, classes, material resources and, in general, the kinds of opportunities necessary for academic success. For instance, recent analyses of data from the states of Alabama, California, New Jersey, New York, Louisiana and Texas reveal that "on every tangible measure- from qualified teachers to access to technology and curriculum offerings- schools serving greater numbers of students of color tended to have

significantly fewer resources than schools serving mostly whites." (Banks *et al.*, 2005, p. 238).

In science education, inequitable opportunities include limited access to high-level science classes, scientific materials and extracurricular opportunities (Darling-Hammond, 1999; Ingersoll, 1999). Oakes' studies (2000) of Californian students' science scores on national exams and course taking patterns reveal that serious opportunity gaps remain between White students and children of color, and between high poverty and non-poverty students. As she claims, segregated minority schools are less likely to offer advanced science courses for students.

Other studies further report that, within schools, urban students in poverty are disproportionately tracked into lower-level classes, with focus on behavioral skills and where science is either presented to them as a static body of knowledge or almost absent from the curriculum (Oakes, 2000; Page, 1990). Along these lines, science teachers working in high poverty schools must teach large classes of students and count on limited academic and financial support to implement innovative curricular strategies. In turn, this contributes to the teaching of science in traditional ways that do not offer students opportunities for developing investigations or independent thinking (Huinker, 1996).

However, I agree with several scholars in science education when they argue that the lack of resources is not the only explanation for high poverty urban students poor test scores or decline in interest in science by the time they finish middle-school (see for instance Calabrese Barton, 2003; Hogan & Corey, 2001; Moll

et al., 1992; Varelas *et al.*, 2002, Warren *et al.*, 2001). As these authors claim, the profound disconnection between school science and the worlds of urban youth is another primary reason for the "demographic imperative" in science education. Their research on science teachers working with urban youth points towards the need to rethink the meanings and practices of science education in order to develop more inclusive teaching pedagogies that capitalize on what urban students bring to school science as a keystone in creating meaningful opportunities for science learning.

Teaching quality and student learning: Teachers matter

Teaching quality and students' outcomes

Although conventional wisdom has often claimed that schools make little difference beyond the influences of students' socioeconomic background, newer evidence demonstrates that schools do make a manifest contribution to what children learn. And it also shows that teachers are an important part of what students take out from their school experiences. The Educational Trust reports compile the results of recent studies that show, for instance, that a students' assigned teacher has a much stronger influence on student learning than other factors such as classroom size (Carey, 2004; Haycock, 1998). Other studies cited in the reports demonstrate that students who were assigned to highly effective

teachers in a row had significantly greater grains in achievement than those who were assigned to less effective teachers.

Furthermore, Bransford *et al.* (2005) summarize several studies that show that differences in teachers' qualifications can account for as much of the variation in student achievement as students' backgrounds or socioeconomic status. This proves to be especially true for students labeled as "at risk," as Strauss and Sawyer (1986) suggest when they claim that: "Our analysis indicates quite clearly that improving the quality of teachers in the classroom will do more for students who are educationally at risk, those prone to fail, than reducing the class size or improving the capital stock by any reasonable margin which would be available to policy makers" (cited in Bransford *et al.*, 2005, p. 14).

Along these lines, several studies in urban science education have shown that teachers who are able to build on students' strengths and values and include community connections are able to create learning environments that foster students' achievement and learning. For instance, Varelas *et al.* (2002) have shown that a teacher who integrated "youth genres" (i.e. young people's discourses and particular ways of knowing and doing) into a 6th grade science classroom was effective in getting students to integrate their personal worldviews and interests into building scientific knowledge. In another example, Bouillion and Gomez (2001) showed the value of building on real world problems identified by students in science teaching. Studying a team of teachers working on a pollution problem along a nearby river as an interdisciplinary anchor to teach science, math, language

arts and civics, they demonstrated that teachers who work with students to identify and solve real world problems are able to foster student learning about key scientific concepts and to increase student interest and sense of self-efficacy about science.

The shortage of highly qualified urban science teachers

Given the importance of teachers in student learning, the diminished access to highly qualified teachers is, perhaps, the biggest inequality in educational opportunities that urban children living in poverty face. Although the shortage of teachers is a problem that affects the entire United States, research shows that the effects of teacher shortages and the provision of qualified teachers are not equally spread. These shortages have disproportionately affected students who are in low-achieving schools, schools with high numbers of students of color and students with high numbers of children who qualify for free or reduced-price lunch (NCTAF, 2003; Zeichner, 2003). As Zeichner (2003) remarks, an important gap exists "between the rhetoric about providing all students with fully qualified and effective teachers and the reality of only some students having access to these teachers" (p. 491).

In 2001-2002, for instance, only 44% of the teachers hired in New York City schools were certified (Gandara & Maxwell-Jolley, 2000). The results published in The Condition of Education (NCES, 2003a) report that the percentage of public high school students who were taught by teachers without certification or a major

in the field they teach was much higher in high minority and high poverty schools than in low minority and low poverty schools in 1999-2000. In general, statistics show that students already exhibiting low academic performance have a higher probability of being taught by an underprepared teacher. As Haycock (2000) of The Education Trust explains:

> Large numbers of secondary teachers lack state certification to teach the subjects they are teaching. When certification data are disaggregated by the economic composition of the school, clear patterns emerge. Students attending high poverty secondary schools (>75% poverty) are more than twice as likely as students in low poverty schools (<10% poverty) to be taught by teachers not certified in their fields. Youngsters attending predominately minority schools are also more likely to be taught by teachers uncertified in their subjects. In fact students attending schools in which African American and Latino students comprise 90% or more of the student population are more than twice as likely to be taught by teachers without certification to teach their subjects (cited in Zeichner, 2003, p. 495)

Again, science education is not an exception to this state of affairs. Ingersoll (1999) has shown that children attending high poverty urban schools have limited access to certified science teachers or to administrators that support high-quality science teaching. In impoverished urban districts of cities like Los Angeles and New York, Darling-Hammond (1999) reports that the percentage of uncertified and underqualified science teachers outweighs the percentage of certified and qualified teachers and that, therefore, most students take science courses with underprepared teachers.

Given this scenario, one important question emerges: What is the reason behind the lack of qualified teachers in urban schools? According to Ingersoll and

Smith (2003) and the National Commission on Teaching and America's Future (NCTAF, 2003), the problem is fundamentally caused by a high rate of teacher attrition. The Commission's report argues that, against the common wisdom that the ability to improve schools and instruction is limited by a national teacher shortage, the real school-staffing problem is teacher retention. The statistics presented in the report show that the inability to support high quality teaching in many of American schools is driven not by too few teachers entering, but by too many leaving. Although each year more than enough new teachers graduate to meet the country's needs, they show that in just three years it is estimated that almost a third of the new entrants to teaching will leave the field, and after five years almost half will be gone. As they state: "When we read about how many teachers a school district must hire in the fall, we should be asking instead about how many left last spring—and why" (p. 8).

In urban schools serving high poverty communities, the national problem of teacher attrition is even worse. At a national level, the report shows that the annual rate of teacher turnover for high poverty public schools is 20%, in comparison to 12.9 % in low poverty schools. The consequence of this high level of teacher turnover and attrition causes urban high poverty schools to be staffed with the highest percentages of first year teachers, the highest percentages of teachers with less than five years of teaching experience, and the lowest percentages of veteran accomplished teachers. The high rate of teacher turnover, in turn, has a very high cost to students by eroding teaching quality and student achievement, as

inexperienced teachers have been found to be noticeably less effective than more senior teachers (NCATF, 2003).

The too common scenario of "the pedagogy of poverty"

As research has shown, effective teachers can make a significant difference in what students take out of their school experience. However, I believe that teachers who are not fully prepared to engage urban youth in meaningful learning can also contribute to perpetuate the inequalities I have described.

Along these lines, I agree with others who claim that the high rate of teacher attrition is not the only reason behind the shortage of effective urban science teachers (Calabrese Barton, 2003; Haberman, 1995). There are teachers who, even when they do not quit their jobs, are unable to cope with the enormous challenges that a very dysfunctional system presents to them. Thus, they start to lower their expectations on their students and on themselves. As a result, they develop a "deficit model" of urban youth and urban schooling that is reflected in their practice (Calabrese Barton, 2003). Martin Haberman (1991) has described this way of teaching as "the pedagogy of poverty":

> Certain acts constitute the core functions of urban teaching at all levels and in all subjects: giving information, asking questions, giving directions, making and reviewing assignments, monitoring seatwork, giving and reviewing tests, assigning and reviewing homework, settling disputes, punishing noncompliance, marking papers, and giving grades. Taken separately, there may be nothing wrong with them. Taken together and performed to systematic exclusion of other acts, they are the pedagogy of poverty-what teachers do and youngsters expect and what parents, the community, and the public assume teaching to be. (p. 290)

Sadly, the picture that Haberman describes is prevalent in most urban classrooms, where students do not participate in learning activities "but in a game that involves obtaining some reward for doing as little as possible in the most superficial way" (Haberman, 2000, p. 208). As a result, "youngsters achieve neither minimum levels of life skills nor what they are capable of learning" (Haberman, 1995, p. 290).

In science teaching, the pedagogy of poverty often involves presenting science as a static body of knowledge and focusing on basic behavioral skills rather than supporting students in developing analytic tools or deep understanding. Starting in elementary school, high poverty minority schools focus on basic scientific knowledge and skills, whereas more affluent schools provide access to richer, problem based learning and enrichment activities (Oakes, 2000).

As research has demonstrated, teachers matter. For good *and* for bad. And they matter the most to students living in high poverty conditions, whose chances to get better life opportunities most of the times depend on the education they receive. As Haycock of The Education Trust (2002) points out: "Students unfortunate enough to face several bad teachers in a row face devastating odds against success" (cited in NCTAF, 2003, p. 35).

Preparing science teachers to succeed in urban classrooms

A call for a specialized preparation

Teaching in high poverty urban settings can be a truly challenging endeavor. On a daily basis, many urban teachers must deal with "horrendous conditions" (Haberman, 1995, p. 25) in the context of institutions that, in many ways, are deeply dysfunctional. These constraints include, for instance, limited resources and support, big classroom sizes and school cultures where the pedagogy of poverty is the norm rather than the exception (Cochran-Smith, 2004; Haberman, 1995; NCATF, 2003).

Additionally, there is another important factor that shapes teachers' experiences in urban schools and causes early burnout: the cultural divide between most teachers and their students. At present, the composition of the American teaching force is relatively homogeneous. Teachers are mostly White European American teachers from middle-class backgrounds who only speak English. On the contrary, the vast majority of students in inner city schools are racial and ethnic minorities, live in poverty conditions and speak a first language other than English (Banks *et al.*, 2005; Ladson-Billings, 1999).

The differences in their life experiences deeply mark the ways teachers can relate to their students. Most urban teachers do not have the same cultural frames of reference and points of view as their students and, in many ways, come from "different worlds" (Banks *et al.*, 2005). As a result, most teachers have difficulty constructing curriculum, instruction and interactional patterns that can help

students to bridge home-school differences and, as a result, many of them see students in deficit ways (Cochran-Smith, 2004).

In science education, the process of bridging experiences becomes even more important, since teaching science requires enculturating students into a particular way of discourse that "takes them beyond the boundaries of their own experiences to become familiar with new explanatory systems, ways of using language and styles of developing knowledge" (Hogan & Corey, 2001, p. 215). For many urban students, this is a true cross-cultural experience. As Haberman (1995) has pointed out, "the school is trying to transform them into the kinds of people doing things they have never seen or experienced first hand" (p. 25).

Given this scenario, I agree with others who claim that providing a specialized preparation for urban teachers is crucial to increase teacher retention and avoid their sense of failure and early burnout (Cochran-Smith, 2004; Haberman, 1995; Ladson-Billings, 1999). As Haberman has put it, new alternatives in urban teacher education are needed, as traditional approaches have proven to be unsuccessful:

> Completing a traditional program of teacher education as preparation for working [in today's urban classrooms] is like preparing to swim the English Channel by doing laps in the university pool. Swimming is not swimming… "Teaching is not teaching" and "kids are not kids"(cited in Ladson-Billings, 1999, p. 233).

Haberman goes further to state that the traditional approach to teacher education is counterproductive for future teachers in poverty schools since it leads them to perceive students as deficient or abnormal. Along these lines, in my own

experience working with urban teachers I have often heard comments such as "many of my students should be placed in special education" or "the majority of these kids are slow learners."

These views are consistent with reports of teachers who started to teach in an urban setting after being successful teachers in other contexts, and who ought to "relearn" how to teach in order to perform effectively with their new student population (Roth *et al*., 2004; Tobin, 2000). In his article "Becoming an Urban Science Educator," Ken Tobin (2000) describes how being an experienced educator with middle-class students in suburban-like schools was not enough for him to succeed in teaching poor minority students in a New York City high school. As he reported: "Every day I enacted activities that I expected to be successful, but they fell short of my expectations and eluded the students' interests" (p. 101). Tobin recalled how being successful in this new environment meant learning to negotiate with students his right to teach them science and being able to connect his enacted curriculum to the interests and knowledge of young people who were ethnically, culturally and socially very different from himself.

If we agree on the need to give teachers a specialized preparation to work in urban schools, a new question follows easily: How should we do that?

As Zeichner (2003) has reported, although there are several programs for urban teacher preparation that are being implemented with good results across the country, unfortunately those programs are not the norm. In fact, the most extended approach to urban teacher education includes adding a few courses on

multicultural teaching to traditional teacher education programs. According to Ladson-Billings (1999), most teacher education institutions have been satisfied with adding "multicultural content," instead of changing the philosophy and the structure of the ways teachers are prepared.

I agree with Ladson-Billings and others who claim that, in order to develop the specialized tools needed to become successful urban educators, preservice and novice teachers need extended field-based opportunities to authentically interact with their students and become enculturated in the discourses and practices of urban schooling (Cochran-Smith, 2004; Haberman, 1995; Tobin, 2005). I believe that this kind of learning is very complex and goes beyond the work that can be done within a few university-based courses on multiculturalism. In fact, teaching in a high poverty urban school involves teaching in a segregated environment where the cultural divide shapes most student and teacher interactions. As Ladson-Billings (1999) has suggested, "teachers refer to teaching in a multicultural setting when, in truth, they are teaching in predominantly African American or Latino schools" (p. 219).

Action research as a tool for preservice teacher education

Within the frame of these field-based experiences, action research has been proposed as a tool to prepare teachers to analyze the complexities embedded in the context of their own teaching practice and take action to improve it. Most of these initiatives have been framed around the student-teaching practicum, with support

from a university-based course. They have mostly focused on analyzing and improving the individual teaching practice (see for instance Noffke, 1995; Price, 2001; Tabachnik & Zeichner, 1999; Zeichner & Gore, 1995).

Looking at these programs, researchers have consistently reported that using action research in teacher education prepares teacher candidates to examine more successfully the environment in which teaching and learning occurs. They have also demonstrated that engaging in action research contributes to expand teachers' reflective skills, foster inquiry habits and gain a deeper understanding of their students (see for instance Cochran-Smith & Lytle, 1999; Noffke, 1995; Zeichner & Gore, 1995).

However, researchers have also called attention to the shortcomings of these programs in terms of supporting preservice teachers' critical reflection and the development of tools to engage in classroom reform. For instance, Price (2001) worked with a group of 11 preservice teachers enrolled in a 1-year master's certification program at the University of Maryland who took a course on action research. In that course, participants explored "issues and ideas that they puzzled about in their day-to-day [student] teaching" (p. 45) and met weekly to discuss issues related to action research and their teaching experiences. He found that by analyzing their student-teaching experience, preservice teachers expanded their understanding of students' thinking, learning and interests, and gained knowledge of their subject matter pedagogy. Yet, although the experience influenced the kinds of changes teacher candidates imagined undertaking in their future practice,

neither of them reported to perceive a significant amount of change in their classrooms or students as a result of their action research project.

This finding is consistent with Zeichner and Gore's (1995) reports in their study of preservice elementary school teachers' participation in action research within their student-teaching experience. The action research experience was part of a 5-year teacher education program at the University of Wisconsin-Madison oriented towards reflective teaching practice. Teachers were supported in their projects by weekly meetings and instructors' guidance. By analyzing teachers' written reports of their projects, the authors reported that engaging in action research had contributed to teachers' understanding of their students' thinking and had made them more aware of the gaps between their own beliefs and their practice. However, the authors also concluded that the program did not foster preservice teachers' genuine reflection. In fact, the majority of teacher candidate's projects revealed no explicit concern for moral or political issues, even though attention to these aspects was an explicit component of the program.

In a study within the field of science education Tabachnik and Zeichner (1999) explored the role of action research in the preparation of preservice science teachers as they participated in a two-semester seminar on action research and conducted action research projects during their student-teaching practicum. This seminar was part of a science teacher education program which goal was "to graduate teachers who held conceptual change conceptions of teaching science and were disposed to put them into practice." (p. 310). Prior to their student-teaching

experience, preservice teachers were introduced to the theory and practice of action research. Then, during their student-teaching semester, each prospective teacher completed an action research project about his or her teaching of science, became part of an action research seminar group that met with the instructors biweekly and also kept reflective journals. Findings of this study are coherent with the literature on action research in teacher education. They indicate that most prospective teachers became more interested in discovering their students' thinking and science understandings. However, although most of the prospective teachers became practiced in eliciting students' prior knowledge, only a few of them were able to use their knowledge of their students' thinking to inform their teaching.

The importance of collaborative communities

Other studies have stressed the importance of programs that place preservice teachers within communities of "collaborative resonance" (Cochran-Smith, 2004, p. 25) as a way to overcome the shortcomings of framing action research around the individual practice. These programs have been structured within various forms of school-university partnerships. These partnerships are based on a close collaboration among all the participants, including practicing teachers, school leadership, students, preservice teachers and university researchers (Cochran-Smith, 2004; Crocco, 2003; Roth *et al.*, 2002; Tobin, 2001; Van Zee *et al.*, 2003). I discuss three key examples next.

Project START, a 5-year preservice program in elementary education (Cochran-Smith, 2004), was framed under the collaboration of teachers, researchers and teacher candidates, who took the role of "researchers, reformers and reflective professionals responsible for critiquing and creating curriculum, instruction, assessment and the institutional arrangements for schooling" (p. 29). Each year, 20 to 25 preservice teachers progressed through the 12-month program as a cohort, participating together in study groups, seminars, courses and teacher-research groups. Subcohorts of 3 to 4 preservice teachers were placed at selected school sites with cooperating teachers who, in a variety of ways, were "working against the grain" (p. 29). These subgroups of student teachers, cooperating teachers and university mentor met together each week to reflect on their work. Findings of 10 years (1989-1999) of the program revealed that teacher candidates learned to embrace an inquiry and reformer's stance on teaching and schooling, starting to make problematic their knowledge and assumptions on children and school culture, confront dilemmas of their teaching practice and engage in collaborative classroom and school reform.

In a second example, Crocco *et al.* (2005) report the outcomes of a yearlong preservice teacher field experience that took place within a Professional Development School (PDS) between Teachers College and an urban secondary school. The school emphasized experiential learning and interdisciplinary work for students and teachers. It also had a central ethos based on a culture of reflective inquiry. Within this PDS, 8 to 10 preservice teachers per year (who were called

interns) took a fuller load than the typical student teaching assignment and work alongside teacher mentors who shared the university-endorsed views of student-centered pedagogy and constructivist learning. Interns also engaged in joint action research projects with teacher mentors. In these studies, they worked together to address school-wide problems of practice such as the use of portfolios for student assessment or the planning of interdisciplinary curriculum and instruction. For instance, in two subsequent years they inquired on the validity on schools' portfolio assessments (which they called "gradfolios") that the school used as a graduation requirement instead of the Regents exams. These action research projects were especially important for the school since proving the validity of gradfolios was crucial to the school's ability to withstand pressures by the NYC Education Department to impose the Regents exams on schools that, as this one, had been granted waivers for them.

The researchers found that teaching and doing action research at the PDS significantly supported preservice teachers in their transition into their first full-time teaching job. For example, interns were able to apply the instructional strategies introduced in their methods courses with the support of mentors who shared their interest in student-centered, constructivist approaches. They were also able to get a deeper understanding of the school culture and build deeper relationships with students and teachers than what is typical for student teaching. They gradually began to take responsibilities more associated to those of a full-time teacher, such as engaging in extracurricular activities. In all, engaging in

action research supported them in making sense of the complex world of the school while developing a reflective, inquiry orientation to teaching.

Finally, in science education, over the last 7 years Tobin and Roth (2005) have been using the approach of co-teaching and cogenerative dialogue as a tool to prepare preservice science teachers to teach in challenging urban high schools "characterized by problems such as teacher turnover and retention, low job satisfaction, and contradictions arising from cultural and ethnic diversity" (p. 313). In this model, one or more preservice teachers are placed for one academic year with a mentor teacher and become a co-teaching team, equally responsible for planning, teaching and evaluating students. Co-teaching is coupled with a collective analysis of the events that took place in the classroom (based on videotaped or other kinds of evidence), conducted jointly by all the teachers, university researchers and student representatives in an attempt to make sense of and improve teaching and learning in that particular classroom and for that group of students.

Research done on this model for teacher education showed that co-teaching allows preservice and experienced teachers to communicate effectively, learning to build collective decisions about immediate and long-term changes to be made in their classrooms. Through cogenerative dialogues, preservice and mentor teachers also learn to collaborate with students to establish and maintain effective learning environments in which the responsibility of learning is shared by all, rather than working towards establishing control over them (Roth *et al.*, 2002; Tobin, 2001).

Transformative action research and urban science teacher education

Given its focus on reform and collaborative communities, I was interested in investigating the potential of transformative action research as a tool for the preparation of teachers who aim to teach science in high poverty urban schools with a vision of social justice. Since this pedagogical vision often goes "against the grain" (Cochran-Smith, 2004, p. 28) of what is typical in many urban schools, transformative action research seemed to be a promising tool for urban teacher education.

Transformative action research builds on the methodology of action research, but it goes further to emphasize the goal of reforming a particular scenario based on what a group of participants perceive as the authentic needs of the context. In this way, transformative action research places the researcher in the role of the learner who attempts to make sense of an authentic situation with the purpose of improving it, and makes the research process a research *with* people, instead of *about* or *for* them (McTaggart, 1997; Oja & Smulyan, 1989).

Although transformative action research seeks to bring change to the daily lives of all the people involved in the research, it is not about any kind of change. As McTaggart (1997) points out, embedded within it there is a vision for social justice in which people work together "toward rationality, justice, coherence and satisfactoriness in workplaces and in other areas of peoples' lives" (p. 6).

It is also important to note that transformative action research is research, not just learning or political activism. This becomes an important statement given the critiques regarding the legitimacy of this methodology to generate valid knowledge (McTaggart, 1997; Oja & Smulyan, 1989). Transformative action research in education aims to achieve new understandings and elaborate theories with the purpose of informing not only the participants involved but also the educational field in general. In doing so, it makes use of a set of methods and practices that seek to ensure the trustworthiness of the knowledge generated, emphasizing the need for compelling evidence to support researchers' claims.

As researchers have suggested, engaging in transformative action research can support teachers to reflect upon their own beliefs and practice, as well as to collaborate with others to improve their teaching and the learning experiences of their students (see for instance Cochran-Smith, 2004; Crocco, 2003; Price, 2005). Yet, much remains to be said about the ways this methodology can support prospective science teachers to succeed in urban classrooms serving high poverty communities. For instance: What kinds of development does transformative action research support in teachers? How does this development occur? In what ways this kind of development helps teachers succeed in urban schools? My study aims to answer these and other questions with the purpose of deepening the understanding on how to prepare effective science teachers for urban children in poverty.

Conceptual framework

A vision for teaching: Teaching science for social justice

I bring to this study a particular vision of science pedagogy that I need to make explicit because it shaped my research in important ways. I believe that urban science teachers must develop tools for what has been called "teaching science for social justice" (Calabrese Barton, 2003). I agree with Cochran-Smith (2004) when she claims that schooling- and I would add, science teaching- must prepare all students "to engage in a satisfying work, function as life-long learners who can cope with the challenges of a rapidly changing global society, recognize inequities in their everyday contexts, and join with others to challenge them" (p. 159). This vision implies the recognition that teaching is always a political and value-laden activity. It also entails a vision of schools as sites for social transformation, "as places where students are educated not only to be critical thinkers, but also to view the world as a place where their actions might make a difference" (McLaren, 1994, p. 6).

Yet, when it comes to real science classrooms, another question easily follows: How can this vision be enacted? And moreover, what, if anything, makes teaching science for social justice unique, especially when we compare it to teaching for social justice in general?

First, I think that one aspect that science education has to contribute for the creation of a more just society is its potential to support students in the

development of inquiry tools to understand and question the world where they live. The subject matter of science leads itself very easily to conducting hands-on investigations where children can experience first hand the process of asking questions to the world. In doing inquiry based activities, students learn to formulate questions related to what they see or what they read, and develop the tools to find answers for themselves.

I believe that this is a truly empowering experience for children, especially because it allows them to be direct producers of knowledge and develop an inquisitive disposition towards reality. I also believe that engaging in inquiry also supports students in feeling confident about themselves and their own capacity to find out answers by engaging in the direct exploration of everyday problems. Moreover, in doing investigations students learn to ask for the evidence behind other people's claims and also to provide evidence to support their own statements.

In order to be socially just, therefore, science teaching must support students in developing inquiry tools such as formulating questions, developing tools for testing their ideas, constructing explanatory models and debating their findings with others. In doing so, it must foster students' abilities to think independently and to evaluate other people's perspectives based on the evidence they provide rather than on the authority that they hold.

Along these lines, I believe that developing tools to question and to evaluate the evidence behind other people's positions is crucial to make informed decisions

and to avoid being manipulated when trying to decide on key issues that may affect oneself or one's community. Supporting children in engaging in a life-long journey of inquiry is a crucial foundation to educate responsible citizens who are agents of their lives and can see the power of knowledge and the value of learning as a way to transform their realities. I agree with Giroux (1990) when he claims that the primary goal of schools is to create "a public sphere of citizens who are able to exercise power over their own lives" (cited in Brooker & Macdonald, 1999, p. 86). As Roth and Calabrese Barton (2004) argue, referring to the goals of science education, "rather than getting science-related stuff into the heads of children, we want to expand their agency, their room to maneuver, and the possibilities of acting and thereby changing their life conditions" (p. 17). Along these lines, I believe that the high status of science within society plays a role in the possibilities of science education to empower students. A good science education can open the doors for students not only to enter science-related careers but also to make their voices louder in attempting to transform their realities. This is especially true due to the inherent authority that scientific knowledge currently holds in society. Knowing and understanding science can be used to support one's goals in front of others and make oneself listened in more effective ways.

Second, I agree with Roth and Calabrese Barton when they claim that scientific literacy should be conceived in terms of "citizen science" (p. 9), a science that is embedded in the concerns, interests and activities of people's everyday lives. In that view, success in science becomes more tied to students' ability to

participate in science-related contexts and to use science knowledge in ways that are meaningful for them and their communities rather than on test scores.

Because of this, I argue that to enact socially just science pedagogies requires teachers to value and build on students' resources –especially those that have not traditionally been sanctioned in school contexts such as funds of knowledge (Moll *et al.*, 1992) and youth genres (Varelas *et al.*, 2002). Building on students' strengths is a key component of constructing spaces with children that are genuinely responsive to their voices and offer them opportunities for meaningful science learning (Calabrese Barton, 2003). Along these lines, the fact that science can be easily connected to everyday phenomena makes it especially suitable for drawing upon students' funds of knowledge, since most students have personal experiences with the subject matter (even if they do not recognize those experiences as science-related) that teachers can leverage in the classroom.

Finally, enacting a vision of teaching science for social justice also involves holding students up to high expectations in terms of the kind of work they must undertake. In science teaching this involves, as I said, to support students in reaching deep levels of conceptual understandings and presenting science in ways that support them in developing tools for analytic and independent thought.

As I said, this vision of science pedagogy framed my research in key manners. First, it shaped what I looked for in fellows' experiences when I analyzed my data. Since I was interested in understanding the ways the program supported them in enacting socially just science pedagogies, I focused on the instances in

which their teaching aligned with this vision, as I will describe later when I speak of hybrid spaces. Second, it framed the kinds of kinds of interactions I had with the participants in my role of a mentor and program coordinator. For instance, I drew on this pedagogical vision –which was also the vision for the program itself- when I raised questions for the fellows regarding the benefits of their transformative action research projects for their students and gave them suggestions to improve their projects.

A vision for learning: Socioconstructivism

In looking at fellows' development over the program, I bring to my study a socioconstructivist epistemology. This lens assumes that an individual's knowledge of the world is always contextually mediated. Learning, therefore, is a process fundamentally shaped by others and framed by the learners' language and culture (Vygotsky, 1978). Building on this epistemology, I draw on Lave and Wenger´s (1991) conception of learning as a situated activity configured through the process of becoming a full participant in a sociocultural practice.

As Lave and Wenger point out, when learners participate in communities of practice, they gradually come to master the knowledge and skills necessary to participate more effectively in those communities. In other words, as people learn, they move from a peripheral participation in the learning community towards a more central position in which they become a fundamental part of the decision and rule-making processes. In this way, learning becomes "a process of enculturation"

(Brown *et al.*, 1989, p.33) and is not just about what learners know, but also how what they know is part of a larger system of practices, norms and values (Brickhouse & Potter, 2001). This lens guided me to pay attention to the ways fellows were able to gradually become more central participants of their partner classrooms communities of practice and to how, in doing so, they developed different teaching tools and knowledge to effectively navigate the context of urban schooling.

Although I focused my analysis on fellows' participation within their partner classrooms community of practice, I also examined the ways other contexts contributed to their growth as urban science teachers. As Peressini and colleagues (2004) have suggested, novice teachers' learning experience is shaped by their trajectories through the multiple contexts of teacher education. This idea was relevant for my study, since the fellows' learning process occurred across the various contexts of the Urban Science Fellows Education Program and their university experience.

In analyzing fellows' participation within various contexts, I also paid attention to the roles they played and how those roles developed over time. According to Lave and Wenger (1991), in learning to participate in a community of practice the learner does not occupy a particular role. Rather, learning is a process in which the learner simultaneously performs in several roles, "each implying a different sort of responsibility, a different set of role relations, and a different interactive involvement" (p. 23), leading towards more central and expert

performances as the process of learning occurs. In my study, fellows took different roles in the classroom. They acted as teachers, teacher helpers, observers, and resource people, among others. They also played the role of students in our weekly meetings, of peers when they participated in the program's discussions and even of experts when they presented their studies and school experiences to the rest of the fellows' community. Understanding their trajectory over the program required, therefore, that I looked closely at these roles and the ways they framed fellows' development.

Finally, the situated framework also brings a focus on the learner as a whole person, or a "person-in-the-world" (Brickhouse & Potter, 2001, p. 52). Learning becomes, under this vision, a process of identity formation. Getting involved in new activities, performing new tasks, and mastering new understandings also means becoming a different person with respect to the possibilities enabled by being able to participate differently within a community. In this process, a person's beliefs become crucial to shape the kinds of practices they decide to undertake. This view is consistent with research in teacher learning, that has shown that teachers' professional decisions and practices must be explained by taking into account the goals, beliefs, knowledge and action plans behind them (Schoenfeld, 1998). This understanding led me to consider the importance of fellows' beliefs in shaping their growth over the program in order to understand their different "entry points" to their individual process of identity formation.

Critical pedagogy

Both the purpose of this study and the vision of teaching science for social justice that I propose are rooted in the ideas of critical pedagogy. Critical pedagogy assumes that education and educational research are political endeavors, influenced by values and moral choices and embedded with a view of what the world should look like. And it goes further to state that the purpose of education should be to provide citizens with the tools to critique and transform their realities towards the creation of a more egalitarian society (Giroux, 1988; McLaren, 1994).

Critical pedagogy envisions research as *praxis* (Freire, 1970). In other words, it argues that action and reflection must inform one another in a dialectical relationship with the underlying purpose of transforming the social reality. My understanding of research is deeply tied to this educational philosophy. I approached this study with the aim of developing a theory regarding how to prepare teachers to succeed in urban schools and, in doing so, to inform my own practice within the fellows program and the teacher education field in general. Within the process, the theory I was developing also shaped the kinds of practices I undertook. For instance, my understandings of fellows' experiences helped me structure the weekly meetings in ways that supported them better in their growth as urban science teachers.

Finally, critical theorists of education have argued that teachers and researchers must understand the role of schooling in both perpetuating and challenging the structures that shape modern society (McLaren, 1994). This

perspective points towards the need to examine the issues of power that take place during teaching and learning practices. In doing so, this perspective extended the socioconstructivist lens that I brought to the study by allowing me to analyze broader issues of power embedded in the fellows' participation within different communities of practice. It also helped me to look at how fellows' participation contributed to challenge or sustain unjust school practices.

Hybrid spaces

Finally, I drew upon the ideas on Elizabeth Moje (2004) and her colleagues to describe the novel spaces of participation that fellows and others generated in their partner classrooms. With novel, I refer to those spaces that aligned with a pedagogical vision of teaching science for social justice and, at the same time, challenged the typical ways of teaching and learning that were available for the participants before.

In analyzing high school students' building of literacy competencies within the context of science learning, Moje and her colleagues have argued for the importance of integrating the multiple "texts" and funds of knowledge that students bring from out-of-school contexts into the classroom discourse. In doing so, they claim, teachers can support youth in learning to navigate the complex literacy practices embedded in high school courses. Their ideas draw upon hybridity theorists, who posit that, in any given community, people draw on multiple resources to make sense of the world and examine how being "in-

between" different knowledges and discourses can shape one's social and cultural practices (Bhabha, 1994, cited in Moje *et al*., 2004).

In their analysis, Moje and colleagues have coined the expression "third space" referring to those instances where the worlds of school and home are reconstructed to form an alternative scenario:

> We call this integration of knowledges and Discourses drawn from different spaces the construction of "third space" that *merges* the "first space" of people's home, community and peer networks with the "second space" of the Discourses they encounter in more formalized institutions such as work, school or church (p. 41).

I found the concept of "third space" helpful to conceptualize the novel spaces that fellows coauthored over the program. In an analogous way to the ways different knowledges and discourses merge to form third spaces, fellows' and other participants' contributions came together to open novel spaces for teaching and learning.

Because these spaces merged the knowledges and discourses of multiple participants such as fellows, partner teachers, students, mentors and school leadership and did not imply a dichotomy between the in-and out-of-school contexts, I chose to call fellows' novel spaces of participation "hybrid spaces." In using the term "hybrid", therefore, I emphasized the multiplicity of the contributions that were needed to make new spaces of participation possible. The idea of hybridity also points towards the fact that these spaces were created in the "in-between" of everyday practices. In other words, it refers to how novel scenarios were created within the interstices of the usual ways of being and doing

of a particular context.