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6. PREPARING SCIENCE TEACHERS FOR DIVERSE AUDIENCES: RACE, CLASS AND SOCIAL JUSTICE

Educational inequalities are part of the educational landscape in the United States. If this reality is accepted as the status quo, then we are, in effect, forgetting the children who *are* left behind year after year. All children must be actively included in a path of educational growth and progress. Although research shows that teachers can make a significant difference in closing the racial test score gap and ensuring better opportunities for all children (Carey, 2004; Haycock, 1998), statistics also show a severe shortage of effective teachers (as measured through different instruments) across American schools. Perhaps most importantly, this shortage does not affect all schools equally. As Carey (2004) and Haycock (1998) of The Education Trust reported, the majority of experienced or effective teachers are not where they are most needed, meaning teaching high poverty Black or Latino children. Students most dependent on public schools to increase their life chances are being shortchanged by the educational system. As Haycock (1998) pointed out, “Students unfortunate enough to face several bad teachers in a row face devastating odds against success” (p. 3).

Given this landscape, this chapter reports on the preparation of science teachers for teaching *all* students. Although many teachers understand that their students come to school with different experiences, strengths, and needs, not all teachers know how to make sense of or utilize this diversity in support of learning for all. We want teachers to question the purposes and goals of science education and what “science for all” might mean. In turn, we want teachers to incorporate such critical thinking as part and parcel of science teaching and learning.

This chapter is structured as follows: First is a brief overview of the challenges of preparing teachers for diversity from a general perspective of teacher education. Next, we move to the specific case of science education and examine what teaching *all* students means in a science education context, arguing for a social justice stance in teacher preparation for diversity. Models and research findings from the field of science education are then presented, offering insights into the preparation of teachers for diversity. Finally, we prioritize a set of suggestions for a research agenda addressing the preparation of science teachers for diversity.

THE CHALLENGE OF PREPARING ALL TEACHERS FOR DIVERSITY

The disparity is growing between the increasingly White, monocultural, and monolingual teaching force and the diversity of children in U.S. schools (Sleeter, 2001; Zeichner, 2003). In her review on preparing teachers for culturally diverse

schools, Sleeter (2001) wrote of the overwhelming presence of Whiteness in preservice programs. According to the National Center for Education Statistics (2004), the 2001 enrollment in public elementary and secondary schools in the United States was 60% White, 38% Black, 17% Hispanic, 4% Asian/Pacific Islander, and 1% American Indian/Alaskan Native, with 19% of students speaking languages other than English. In contrast, the teaching force in the United States in 2000 was 84% White, 8% Black, 6% Hispanic and 2.5% belonging to other minority groups.

At the same time, the National Commission of Teaching for America's Future (NCTAF, 2003) reported that the major reasons for the lack of qualified teachers in many American schools are the high rates of teacher turnover and attrition. Yet, schools serving high-poverty urban communities are the ones with the highest rate of teacher attrition. At a national level, the annual rate of teacher turnover for high-poverty public schools is 20%, in comparison to 12.9% in low poverty schools (NCTAF, 2003). This rate is not surprising since, in order to succeed in these schools, teachers need to navigate effectively a context that includes competition for limited resources and support, large class sizes, and in most cases, a deep cultural divide between teachers and students (Banks et al., 2005; Ladson-Billings, 1999).

Facing these challenges is not easy for most beginning teachers, who end up leaving the profession during the first years of practice (NCATF, 2003). Moreover, some of the teachers who remain teaching in high-poverty schools and schools that serve a majority of African American and Latino students learn to "survive" by lowering their expectations for their students and for their own pedagogical practices. In turn, developing a deficit model leads them to start enacting what Haberman (1991) described as "the pedagogy of poverty" (p. 290).

The cultural gap is just as much of an issue when teachers typically live, participate in, and represent different social worlds from the students they teach (Ladson-Billings, 1999). Learning to teach for diversity, therefore, is related to learning to teach those "others," whom, as Delpit (1988) has put it, are other people's children. This learning can be extremely difficult for teachers, since it involves understanding the cultural frames of reference and points of view of students who basically "live in differential existential worlds" (Gay, 1993, in Cochran-Smith, 2004, p. 6).

Preservice teachers, for example, often hold a deficit view of urban, African American, or Latino youth. Such a perspective attributes "failures to learn" to the students or the students' families rather than to inequities in the processes of schooling (Goodlad, 1990; McIntyre, 1997). Schultz, Neyhart, and Reck (1996), in a survey of 300 preservice teachers, found that preservice teachers tend to have stereotypic beliefs about urban children, such as the belief that urban youth have attitudes that interfere with education (for similar findings, see also Wolffe, 1996; Terrill & Mark, 2000; Lazar, 1998; Groulx, 2001).

One important factor in the support of teachers to bridge this cultural gap and, therefore, be effective with all students is appropriate preparation around issues of diversity (Cochran-Smith, 2004; Haberman, 1995; Ladson-Billings, 1999).

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However, science teacher preparation programs that prepare teachers for diversity are, at present, the exception rather than the norm (Ladson-Billings, 1999). The current scenario in teacher education, especially for schools serving students from racial, linguistic, or ethnic minority backgrounds, is more and more aligned with “the deregulation agenda” (Zeichner, 2003). This agenda describes teaching as a technical activity that mostly relies on content knowledge and communication skills and calls for short intensive training programs—or, sometimes, for no programs at all—that place “competent graduates” directly in the classroom.

ARGUING FOR A SOCIAL JUSTICE STANCE IN SCIENCE EDUCATION

The Role of Social Justice in Science Teacher Education

How do teacher educators take up the challenge of preparing science teachers to teach all students? Although it is widely recognized—and sometimes contested—that issues of equity, diversity, and social justice are important, little consensus exists on how these issues ought to take form in teacher education, especially in the domain of content-based instruction like science. Early work in this area relied primarily on the development of stand-alone courses in multicultural education. Yet, these approaches were, in most cases, fragmented components of larger programs, with limited impact on teachers’ beliefs and practices regarding issues of diversity (Cochran-Smith et al., 2004; Goodlad, 1990; Grant, 1994; Grant & Secada, 1990).

Moving beyond these early efforts has proven somewhat difficult for a number of reasons. Part of the challenge is that little policy attention has been focused on issues of social justice in teacher preparation, which is a key aspect to preparing teachers for diversity. Too often, knowledge of diversity and social justice are viewed as something distinct from disciplinary knowledge. Research into preparing urban science educators reveals that new teachers often view a commitment to children to be in conflict with a commitment to subject matter knowledge (Vora, 2006). Recent backlash against preparing teachers for diversity frequently pits these stances against each other, as if social justice implies a lack of attention to rigorous science knowledge (“Merit at Columbia,” 2006). Yet, there is compelling evidence that a social justice stance can nurture deep conceptual understandings in science (Basu, in press; Calabrese Barton & Tan, 2007), the development of identities supportive of science learning (Tan & Calabrese Barton, in press), and deep engagement in science among low-income urban youth. This last point is critical, given that youth from low-income urban backgrounds are not only underrepresented in the sciences but also, as demonstrated earlier, are the most likely to lack access to high-quality instruction.

Cochran-Smith’s (1999, 2001) work has helped open up the discourse around social justice and teacher education. In doing so, she has reminded us of three key ideals. First, that social justice ought to be in the front and center of teacher

education if it is to have a sustained impact of the preparation of teachers (Ladson Billings, 1999; Weideman, 2002). Second, that teaching ought to be framed as a political activity and learning as transformative. If issues of social justice and diversity are to be taken up in deep and consequential ways, then discourse on teacher learning and teacher knowledge must embrace the perspective that teachers' work is inherently "interpretive, political, theoretical, as well as practical, strategic, and local" and that teacher learning is an ongoing "process of transformation" (Cochran-Smith, 2000, p. 18). Discourse must also consider the oppressive tendencies and regressive policies of society can be counteracted by viewing students from an antideficit perspective – as "makers of knowledge" and capable of meeting rigorous, high expectations (Cochran-Smith, 2000). Such an antideficit perspective is at the heart of teaching for social justice and a necessary step in helping teachers develop cultural congruence and a critical perspective (Ladson-Billings, 1999). Cutting across these three ideals is the belief that teaching and learning for social justice is not distinct from teaching and learning about a specific content area, including science. Teacher education students require opportunities to explore their discipline and the teaching of that discipline through a lens of social justice.

The integration of social justice in teacher education programs has proven difficult, at best. The impact of such interventions on prospective teachers varies in large part because integration of social justice issues depends on the specific teacher education programs (i.e., whether they teach social justice as an individual, organizational, or institutional concern), as well as on prospective teachers' backgrounds and experiences (McDonald, 2005; Weideman, 2002). As described earlier, many teachers come to teaching with stereotypical views of urban learners or what these students might need to succeed. Research also suggests that teachers' often tacit beliefs about the nature of science may influence the way they teach and their intended learning goals (e.g., Tobin, McRobbie, & Anderson, 1997; Tobin & McRobbie, 1996; Tobin, Tippins, & Hook, 1994). It is important to acknowledge the possible interplay between such beliefs and teachers' pedagogy when preparing science teachers to teach a diversity of students. Thus, the ways teachers learn to examine their own belief systems – about students, schooling, *and* science – is critical to preparing them successfully to teach all learners. Furthermore, few examples exist of successful integration of social justice in teacher education programs, which is not surprising, given the backdrop of more general challenges within the teacher education community to define and assess the complex work of teacher education (Florio-Ruane, 2002; Wilson, Floden, & Ferrini-Mundy, 2002), teacher knowing, and teacher learning (Lampert & Ball, 1998).

The Special Case of Science

We find the situation particularly pronounced in the field of science education. Attention is typically diverted from science education toward literacy and mathematics, while the number of uncertified science teachers in the largest American cities and in rural districts is ever increasing. In high-poverty schools,

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the number of teachers teaching science out of field is greater than the number teaching in field (Ingersoll & Smith, 2003). In addition, those teachers with the strongest preparation in the sciences who freely elect to teach in the poorest city schools have been reported as having the highest burnout rate, usually leaving their inner-city teaching positions before they have completed their third year of teaching.

We believe that science, as both a discipline of study and an everyday practice, is a particularly important domain for fostering equity and social justice across all sectors of society. Many are quick to point out that a sound education offers access to high-paying and powerful professions in today's increasingly technological and scientifically driven world. However, science also provides individuals with the knowledge and skills for critically understanding and evaluating their bodies, health, environments, communities, and worlds. In fact, the subject matter of science lends itself easily to children conducting hands-on investigations, in which they directly experience the process of asking their own questions and finding their own answers. Engaging in science inquiry can position students as producers of knowledge and support them in developing an inquisitive disposition toward reality. In this way, science learning can foster students' abilities to think independently and to evaluate other people's perspectives based on evidence instead of blindly accepting authority. Unfortunately, science literacy is often assumed to be limited to mastery of certain content knowledge, without consideration for how students learn to *generate knowledge and use it in their own worlds*. Part of learning to teach science is learning to recognize the ways in which scientific literacy enables students to enact agency in their own lives.

SUPPORTING SCIENCE TEACHERS IN TAKING A STANCE ON DIVERSITY: WHAT THE RESEARCH TELLS US

Learning to teach science across diversity means developing deep understandings of one's self, as well as of students' emerging identities and the cultural resources they bring to the classroom. It also means learning to identify how students' resources potentially connect or stand in conflict with the knowledge, culture, and practice of school or academic science and how to develop pedagogical strategies based on that understanding. Teaching for diversity includes both *what* one knows and *how* one uses that knowledge to promote science learning among all students. In particular, different studies suggest that learning to teach for diversity involves learning along three important trajectories: (a) a teaching identity grounded in a desire to act for change; (b) a knowledge base that supports teachers in identifying the relationship between access to science and equity in society; and (c) pedagogical and curricular strategies that bridge the cultural knowledge and experiences of youth and school, or academic, science. These three domains are similar to those proposed by other sociocognitive researchers in teacher learning (Peressini, Borko, Romagnano, Knuth, & Willis, 2004).

An Agentic Teaching Identity

Peressini et al. (2004) described identity as a central component of the development of teachers. They elaborate on cognitive aspects of identity, such as teacher knowledge, beliefs, or goals, as well as sociocultural aspects, like the ways teachers participate in communities of practice and present themselves to others. Identity is important because it “shapes the ways in which a teacher frames and addresses problems of practice. It serves as a lens through which teaching is analyzed, understood, and experienced” (p. 80). From this perspective teachers’ emergent identities are, arguably, forged out of a balancing act between their capacity for individual agency and their experienced constraints and affordances (Boaler & Greeno, 2000). Learning to teach science for diversity, especially in high-poverty schools, is, therefore, about forging a teaching identity built upon a desire to work toward an equitable society by providing all students with high-quality opportunities to interact with and pursue science. Such an “agentic identity” is cultivated through one’s knowledge of science, students, self, teaching beliefs, and the cultural context in which the teaching takes place, which includes an understanding of the resources within that context that can be used to support student learning.

Two recent studies (Furman, 2006; Vora, 2006) address the subject of teacher identity as it relates to learning to teach science for social justice. Furman (2006) demonstrated how preservice science teachers can develop tools to act for change when given opportunities to coauthor new pedagogies that draw upon their preexisting, deeply engrained beliefs about teaching and when participating in contexts of distributed expertise, where more experienced others supported them in their endeavors. Her study also described how preservice science teachers adopted agentic identities grounded in a deep understanding of the school context and developed tools to challenge unjust classroom practices. A key component of the preservice teachers’ development of agentic identities was the ability to position themselves as learners in front of the students and to envision students as partners in the construction of meaning in the science classroom. In doing so, they were able to rethink their pedagogical strategies in order to reach all students meaningfully.

Vora’s (2006) study revealed that new teachers were more successful at supporting meaningful science learning in the high school classroom when they talked about themselves with other teachers as educators for social justice. She also shows how their effectiveness for all students was shaped by their ability to articulate a complex and context-driven understanding of the meanings of social justice in science, in their classrooms, and in schools.

These two studies are consistent with other findings that highlight the importance of teachers’ abilities to make a difference in their science classrooms when they see themselves as agents of change and when they understand their actions as culturally negotiated (Roth, Tobin, Carambo, & Dalland, 2004; Tobin, 2000, 2001). As this body of work reveals, developing an identity grounded on a desire and the tools to act for change is crucial to learning to teach for diversity.

This is especially true because teaching for diversity in the current American educational landscape often means challenging the status quo and engaging in what Cochran-Smith (2004) has called “teaching against the grain.”

A Knowledge Base Linking Access to Science, Society, and Equity

Learning to teach science involves knowledge both of the discipline and of pedagogical tools to transform disciplinary knowledge into classroom practices (Peressini et al., 2004; Shulman, 1987). However, an understanding of the way in which knowing and doing science can expand students’ access to power and resources is integral for teaching across diversity (Hodson, 1999; Upadhyay, Calabrese Barton, & Zahure, 2005; Zahure & Calabrese Barton, 2002). At the core of this learning is a deep understanding of the societal *inequities* that result in differential opportunities in science education for different groups of students and the ways they play out in one’s school and classroom life (Ladson-Billings, 1999)

Ladson-Billings (1999) argued that, first and foremost, teachers of academic subjects are teachers of children. If teachers are to successfully reach youth who have been underserved in the educational system, they also need to understand the practice of teaching as, fundamentally, a practice of equity. This, in turn, involves an understanding of how larger system forces actively position individuals and groups to have less power or access to resources. Teachers can also learn about ways schools can contribute to, challenge, or perpetuate those inequities. In other words, teachers must understand how and why students benefit differentially from the current science education system in terms of achievement, access, and opportunity.

Several studies in out-of-school contexts offer important clues about how power, culture, and access to science commingle in the daily lives of high-poverty urban youth. These studies show how students with low academic standing in science class often fare quite well in science-related activities in out-of-school settings. For example, in a series of studies, Calabrese Barton and her colleagues uncovered the ways in which high-poverty African American and Latino urban youth know and use science in their out-of-school lives to support their life goals and their position within their community or to promote change (Calabrese Barton, 2003a, 2003b; Calabrese Barton & Yang, 2000).

Teachers can increase their capacity to devise and enact equitable science teaching practices with knowledge, skills, and experience in identifying how the normative practices of schooling can position youth without power (Olitsky, 2006; Seiler, 2001). Olitsky (2006), for example, revealed that teacher knowledge of and support of student interaction rituals that fell outside the typical repertoire of accepted classroom activities showed an increase in student learning. While outside the U.S., Upadhyay et al. (2005) showed that teacher knowledge of the relationship between science, society, and individual and community power in urban Pakistan can shape a teacher’s science practice in ways that support student learning and engagement with science.

As these studies demonstrate, a knowledge of the relationship between access to science and social equality supports teachers in making pedagogical and curricular choices that support student learning in science and in using science to promote their own personal agency.

Pedagogical and Curricular Strategies and Approaches for Bridging Students' Cultures With the Culture of School Science

A recent area of concern for science teacher education for diversity has been the focus on learning to develop curricular and pedagogical approaches to bridge students' cultures with the culture of school science. For example, Tobin (2006) reported on a set of case studies examining how teachers learn to foster deeper participation in science by valuing students' cultural practices and integrating them to their own teaching practice. He showed, for instance, how a teacher who integrated verbal fluency, expressive individualism, rhythmic use of his body, and emphatic gestures that aligned with his students' modes of communication fostered deeper participation and learning among his students. Tobin indicated that the "key implication is the necessity for teachers and students to learn how to interact successfully in ways that produce positive emotional energy, a sense of belonging to the class, and a commitment to shared responsibility for one another's participation" (p. 219).

Similarly, research into students' world views and the science views of indigenous peoples provides some insight into specific strategies for teaching all learners (Aikenhead 2006; Allen & Crawley, 1998, Chinn, 2006). For example, Chinn (2006) detailed how teachers can build science knowledge about and relationships with individuals from different cultural backgrounds in support of equitable science teaching. She showed that teachers learned to connect cultural understandings such as a Hawai'ian sense of place to curriculum development and instruction when they were first supported by "cultural mediators" in talking about common science learning goals and cultural practices with members of the local community. Chinn provided evidence that communities of practice can be established, in which participants develop cross-cultural knowledge and literacy for the development of locally relevant, place and standards-based curricula and pedagogy.

Aside from these two areas of work, we can also pose the question, "What other kinds of pedagogical and curricular strategies might be available to support teachers in building connections between the worlds of academic science and the worlds of their students?" Although relatively few studies take up the question of teacher learning to bridge students' and school worlds, there is a growing body of literature focusing on the power of specific curricular and pedagogical tools that support learning among African American, Latino, inner-city, English language learners, and low-income students. These studies can be grouped into two categories: appropriation frameworks and congruence frameworks.

Appropriation frameworks highlight the ways in which students learn to appropriate or assimilate science content and culture. They are grounded in the

belief that science is a cultural practice, with its own ways of talking, acting, and becoming a member of a community and that students' cultural understandings of science can be used to enhance the learning process. Appropriation frameworks also draw upon the idea that the process of learning to become part of the scientific culture ought to be transformative for students, for the classroom-based scientific culture they join, and for the teachers who help form that culture. Examples of appropriation frameworks include youth genres (Varelas, Becker, Luster, & Wenzel, 2002), everyday sense making (Warren, Ballenger, Ogonowski, Rosebery, & Hudicourt-Barnes, 2001), cultural/science toolkits (Elmesky, 2003; Seiler, 2001), and merging science practices (Calabrese Barton, Tan, & Rivet, in press).

Appropriation frameworks key us into the diversity of resources that youth draw upon to learn science – especially those resources not traditionally viewed as scientific. They also illustrate how even the most experienced teachers can struggle with the challenge of knowing what to do with students' ways of sense-making. These frameworks shed insight into some of the less-spoken-of challenges teachers face when attempting to implement reform-based science education: conflicts in science class can and do emerge when the ideals of science (i.e., collaboration, shared responsibility) conflict with the ideals of schooling (i.e., individualism) or the ideals of students (individual ownership).

Congruence frameworks, which include congruent third space (Moje, 2004), instructional congruence (Fradd & Lee, 1999; Lee & Fradd, 1998) and composite culture (Hogan & Corey, 2001), describe pedagogical practices bridging the worlds of students with the worlds of science and school in ways meant to be empowering and relevant to students. Studies focused on congruence pay close attention to the funds of knowledge (Gonzales & Moll, 2002) that students bring to the classroom and those required to do well in science in a school setting. How those funds of knowledge are validated and applied meaningfully in the learning of science is the crux of this set of studies.

Congruence suggests that learning in urban classrooms is embedded with power relations that frame what is labeled scientific or who is capable of learning science. The findings from these studies suggest that studying what happens when instructional models of congruence are applied in urban schools would be important. Such studies provide more knowledge about how such models impact youth achievement in science, as well as their visions of doing science and being a part of the scientific community.

In all, the appropriation and congruence framework studies demonstrate how learning to teach for diversity is deeply connected to developing pedagogical tools to bridge the worlds of students and school science. However, these studies represent the beginnings of our understanding of these connections and tools. Much research remains to be done in terms of how to support teachers to construct these tools and then integrate them into their teaching in ways that respond to the affordances and constraints of their particular context of practice.

NEXT STEPS

Recommendations for a Research Agenda

In preparing teachers for diversity, teacher educators must be prepared to work in and with a variety of tensions. For example, the culture of school science teaching might not support “science for all.” It is possible to misinterpret the calls for teaching to diversity and further other, stereotype, or essentialize groups of students. Knowledge about students and knowledge of self have to become more explicit and open and part of the discourse of science teacher education. With these concerns in mind, we make recommendations for possible research efforts in three key areas:

- Synthesis of the literature on research, policy, and legal advances. This chapter provides a glimpse into some of the critical studies focused on learning to teach science across diversity. However, a vast body of literature addresses learning to teach for diversity outside of science education and across a wide variety of school contexts. Furthermore, several critical cases have been taken up in state courts that speak directly to what teachers ought to know, be able to do, and have access to in their efforts to teach science to all students. We recommend a more detailed synthesis of the literature be conducted, which includes a review of recent court cases, legislation, and other relevant activities.
- Studies of teachers’ trajectories and contexts in learning to teach for diversity. Studies of this type would include investigations of research into understanding (a) teacher identity and agency development, (b) teacher learning about issues of science, society, and equity and how this learning connects to teacher beliefs and practices, and (c) a knowledge base of pedagogical and curricular strategies for building connections between the culture of learning school science and students’ worlds. Example from each category include the following:
 - Identity and agency: First, studies are needed that investigate how teachers serve as cultural brokers, with respect, for instance, to science and majority/minority cultures. Second, we need studies of trajectories of teacher development to see how they take the big ideas around diversity and integrate them into their teaching identity and practice. Third, we also need large-scale studies of when and why teachers leave their placements because of issues related to race, class, or equity.
 - Teacher learning about issues of science, society, and equity and its connection to teacher beliefs and practices. Studies are needed of teachers’ pedagogical context knowledge and of how teachers learn to negotiate common understandings of best practice for their students (i.e., negotiations with students, with other teachers, and with family and community).
 - Studies of pedagogical strategies and frameworks drawing upon students’ cultural experiences. Studies are needed on the role and importance of different appropriation and congruence frameworks and how teachers might learn to use these to adapt their curricular and pedagogical approaches for their students. These studies should extend the work about children’s cultural

resources and practices to the domain of science education. For example, it would be important to investigate whether ideas like funds of knowledge (Gonzalez & Moll, 2002) and cultural modeling frameworks (Lee, 2006) carry the same instructional power in science as they do in mathematics and literacy.

- Investigating different models for science teacher education. Research into different models of science teacher preparation for diversity ought to be studied for ways they prepare teachers to develop identities, knowledge, and skills for diverse audiences. Research should also examine how different models of science teacher education result in differences in teacher retention and satisfaction in diverse settings. For instance, investigations might include concrete examples of (a) how different teacher education programs prepare teachers to teach science for social justice and diversity; (b) how these models of teacher education help beginner teachers to enact teaching science for social justice and diversity in the classroom; (c) how school culture and context enable or discourage teachers to teach science for social justice and diversity; (d) how technology can help to merge field work and university courses in the context of preservice teacher preparation; (e) how university science faculty members teach content classes to new teachers with a focus on issues of equity and social justice. Research should also be conducted into those teacher education programs successfully recruiting teachers from ethnic and linguistic minority backgrounds and into those school districts successfully retaining diverse teaching forces.

These research recommendations will require new and different kinds of dialogue within the science education community and between the science education community and other important groups, such as school districts, policy makers, lawyers, and families. Furthermore, we believe that the science education community must be thoughtful in fostering dialogue that includes the voices of diverse audiences in order to ensure that different perspectives are heard. Voice may be fostered among diverse audiences, especially the voices of African American and Latino parents and youth, urban and rural parents and youth, and English language learner parents and youth, may come about through particular research methodology, if participatory methodologies are used to support participant perspectives. However, voice may also be fostered through newly created spaces for dialogue.

The United States is increasingly ethnically, racially, and linguistically diverse. Language, race, and socioeconomic status can profoundly impact how students participate in the U.S. education system and can also impact their access to high-quality schooling. Teachers must be expected to know about diversity and be prepared to integrate that knowledge into science teaching. Until this requirement is realized as a necessary step in learning to teach science, rather than as an “add on” for those teachers choosing to pursue teaching in the inner cities, then this country will commission another generation of teachers without the skills, knowledge, and mission to truly educate all students.

REFERENCES

- Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. New York: Teachers College Press.
- Allen, N. J., & Crawley, F. E. (1998). Voices from the bridge: Worldview conflicts of Kickapoo students of science. *Journal of Research in Science Teaching*, 35(2), 111-132.
- Banks, J., Cochran-Smith, M., Moll, L. C., Richert, A., Zeichner, K., LePage, P., et al. (2005). Teaching diverse learners. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world* (pp. 232-274). San Francisco: Jossey-Bass.
- Boaler, J., & Greeno, J. G. (2000). Identity, agency and knowing in mathematics worlds. In J. Boaler (Ed.), *Multiple perspectives on mathematics teaching and learning* (pp. 171-200). Stamford, CT: Ablex Publishing.
- Basu, S. J. (in press). How students design and enact physics lessons. *Journal of Research in Science Teaching*.
- Calabrese Barton, A. (2003a). *Teaching science for social justice*. New York: Teachers College Press.
- Calabrese Barton, A. (2003b). Kobe's story: Doing science as contested terrain. *Qualitative Studies in Education*, 16(4), 533-552.
- Calabrese Barton, A., Tan, E., & Rivet, A., (in press). Urban girls merging science practices. *American Education Research Journal*.
- Calabrese Barton, A., & Tan, E. (2007). *Funds of knowledge, discourse and hybridity*. Manuscript submitted for publication.
- Calabrese Barton, A., & Yang, K. (2000). The culture of power and science education: Learning from Miguel. *Journal of Research in Science Teaching*, 37(8), 871-889.
- Carey, K. (2004). The real value of teachers. *Thinking K-16*, 8(1), 3-32.
- Chinn, P. (2006). Preparing science teachers for culturally diverse students: Developing cultural literacy through cultural immersion, cultural translators and communities of practice. *Cultural Studies in Science Education*, 2(1), 367-402.
- Cochran-Smith, M. (1999). Learning to teach for social justice. In G. A. Griffin (Ed.), *The education of teachers* (pp. 114-144). Chicago, IL: University of Chicago Press.
- Cochran-Smith, M. (2000). The future of teacher education: Framing the questions that matter. *Teaching Education*, 11(1), 13-24.
- Cochran-Smith, M. (2001). Higher standards for prospective teachers: What's missing from the discourse? *Journal of Teacher Education*, 52(3), 179-181.
- Cochran-Smith, M. (2004). *Walking the road: Race, diversity and social justice in teacher education*. New York: Teachers College Press.
- Delpit, L. (1988). The silenced dialogue: Power and pedagogy in educating other people's children. *Harvard Educational Review*, 58(3), 280-298.
- Dillard, C. B. (1997). Placing student language, literacy, and culture at the center of teacher education reform. In J. E. King, E. R. Hollins, & W. C. Hayman (Eds.), *Preparing teachers for cultural diversity* (pp. 85-96). New York: Teachers College Press.
- Elmesky, R. (2003). Crossfire on the streets and into the classroom. *Cybernetics and Human Knowing*, 10(2), 29-50.
- Florio-Ruane, S. (2002). More light: An argument for complexity in studies of teaching and teacher education. *Journal of Teacher Education*, 53, 206-217.
- Fradd, S., & Lee, O. (1999). Teachers' roles in promoting science inquiry with students from diverse language backgrounds. *Educational-Researcher*, 28(6), 14-20.
- Furman, M. (2006). *Becoming urban science teachers by transforming the middle school classroom*. Unpublished dissertation. Teachers College Columbia University, New York.
- Gonzalez, N., & Moll, L. (2002). Cruzando el Puente: Building bridges to funds of knowledge. *Educational Policy*, 16(4), 623-641.
- Goodlad, J. I. (1990). *Teachers for our nations' schools*. San Francisco: Jossey-Bass.

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- Grant, C. (1994). Best practices in teacher education for urban schools: Lessons from the multicultural teacher education literature. *Action in Teacher Education*, 16(3), 2-18.
- Grant, C. A., & Secada, W. G. (1990). Preparing teachers for diversity. In W. R. Houston (Ed.), *Handbook of research on teacher education* (pp. 404-422). New York: MacMillan.
- Groulx, J. G. (2001). Changing preservice teacher perceptions of minority schools. *Urban Education*, 36(1), 60-92.
- Haberman, M. (1991). The pedagogy of poverty vs. Good teaching. *Phi Delta Kappan*, 73, 290-294.
- Haberman, M. (1995). The dimensions of excellence in programs preparing teachers for urban poverty schools. *Peabody Journal of Education*, 70(2), 24-43.
- Haycock, K. (1998). Good teaching matters. A lot. *Thinking K-16*, 3(2), 3-14.
- Hodson, D. (1999). Going beyond cultural pluralism: Science education for sociopolitical action. *Science Education*, 83, 775 – 796.
- Hogan, K., & Corey, C. (2001). Viewing classrooms as cultural contexts for fostering scientific literacy. *Anthropology and Education Quarterly*, 32(2), 214-243.
- Ingersoll, R., & Smith, T. (2003). The wrong solution to teacher shortage. *Educational Leadership*, 60(8), 30-33.
- Ladson-Billings, G. (1999). Preparing teachers for diverse student populations: A critical race theory perspective. In A. Iran-Nejad & P. D. Pearson (Eds.), *Review of research in education* (Vol. 24, pp. 211-247). Washington, DC: American Educational Research Association.
- Lampert, M., & Ball, D. (1998). *Teaching, multimedia, and mathematics: Investigations of real practice*. New York: Teachers College Press.
- Lazar, A. (1998). Helping preservice teachers inquire about caregivers: A critical experience for field-based courses. *Action in Teacher Education*, 19(4), 14-28.
- Lee, C. (2006). 'Every good-bye ain't gone': Analyzing the cultural underpinnings of classroom talk. *International Journal of Qualitative Studies in Education*, 19(3), 305-327.
- Lee, O., & Fradd, S. H. (1998). Science for all, including students from non-English-language backgrounds. *Educational Researcher*, 27, 12-21.
- McDonald, M. (2005). The integration of social justice into teacher education programs. *Journal of Teacher Education*, 56, 5, 418-435
- McIntyre, A. (1997). *Making meaning of whiteness: Exploring racial identity with white teachers*. Albany: State University of New York Press.
- Merit at Columbia. (2006, October 12). Retrieved from the *New York Sun* Web site: <http://www2.nysun.com/article/41379>
- Moje, E. (2004). Working toward third space in content area literacy: An examination of everyday funds of knowledge and discourse. *Reading Research Quarterly*, 39(1), 38-70.
- National Center for Education Statistics. (2004). *The condition of education, 2004*. Washington, DC: U.S. Department of Education.
- National Commission on Teaching and America's Future. (2003). *No dream denied: A pledge to America's children*. Washington, DC: Author.
- Olitsky, S. (2006). Promoting student engagement in science: Interaction rituals and the pursuit of a community of practice. *Journal of Research in Science Teaching*, 44, 33-56.
- Peressini, D., Borko, H., Romagnano, L., Knuth, E., & Willis, C. (2004). A conceptual framework for learning to teach secondary mathematics: A situative perspective. *Educational Studies in Mathematics*, 56, 67-96.
- Roth, W.-M., Tobin, K., Carambo, C., & Dalland, C. (2004). Coteaching: Creating resources for learning and learning to teach chemistry in urban high schools. *Journal of Research in Science Teaching*, 41, 882-904.
- Schultz, E., Neyhart, T., & Reck, U. (1996). Swimming against the tide: A study of prospective teachers' attitudes regarding cultural diversity and urban teaching. *Western Journal of Black Studies*, 20(1), 1-7.
- Seiler, G. (2001). Reversing the standard direction: Science emerging from the lives of African American students. *Journal of Research in Science Teaching*, 38(9), 1000-1014.

- Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57(1), 1-22.
- Sleeter, C. E. (2001). Preparing teachers for culturally diverse schools: Research and the overwhelming presence of whiteness. *Journal of Teacher Education*, 52(2), 94-106.
- Tan, E., & Calabrese Barton, A. (in press). From peripheral to central, the story of Melanie's metamorphosis in an urban middle school science class. *Science Education*.
- Terrill, M., & Mark, D. L. H. (2000). Preservice teachers' expectations for schools with children of color and second-language learners. *Journal of Teacher Education*, 51(2), 149-155.
- Tobin, K. (2000). Becoming an urban science educator. *Research in Science Education*, 30(1), 89-106.
- Tobin, K. (2001). Learning/knowing how to teach science in urban high schools. *Educational Horizons*, 80(1), 41-45.
- Tobin, K. (2006). Aligning the cultures of teaching and learning science in urban high schools. *Cultural Studies in Science Education*, 2(1), 219-252.
- Tobin, K., & McRobbie, C. J. (1996). Cultural myths as constraints to the enacted science curriculum. *Science Education*, 80(2), 223-241.
- Tobin, K., McRobbie, C., & Anderson, D. (1997). Dialectical constraints to the discursive practices of a high school physics community. *Journal of Research in Science Teaching*, 34(5), 491-507.
- Tobin, K., & Roth, W.-M. (2005). Implementing coteaching and cogenerative dialoguing in urban science education. *School Science and Mathematics*, 105(6), 313-322.
- Tobin, K. G., Tippins, D. J., & Hook, K. (1994). Referents for changing a science curriculum: a case study of one teacher's change in beliefs. *Science & Education*, 3, 245-264.
- U.S. Census Bureau. (2001). *National demographic profile*. Washington, DC: U.S. Bureau Public Information Office.
- Varelas, M., Becker, J., Luster, B., & Wenzel, S. (2002). When genres meet: Inquiry into a sixth-grade urban science class. *Journal of Research in Science Teaching*, 39(7), 579-605.
- Uphadayay, B., Calabrese Barton, A. & Zahur, R. (2005). Teaching science for political and social change. *Science Education*, 89(5), 725-744.
- Vora, P. (2006). *Preparing science teachers to teach for social justice in urban schools*. Unpublished doctoral dissertation, Teachers College Columbia University, New York.
- Warren, B., Ballenger, C., Ogonowski, M., Rosebery, A., & Hurdicourt- Barnes, J. (2001). Rethinking diversity in learning science: The logic of everyday sense making. *Journal of Research in Science Teaching*, 38(5), 529-552.
- Wiedeman, C. R. (2002). Teacher preparation, social justice, equity: A review of the literature. *Equity & Excellence in Education*, 35(3), 200-211.
- Wilson, S., Floden, R., & Ferrini-Mundy, J. (2002). Teacher preparation research: An insider's view from the outside. *Journal of Teacher Education*, 53, 190-205.
- Wolffe, R. (1996). Reducing preservice teachers' negative expectations of urban students through field experiences. *Teacher Education Quarterly*, 23(1), 99-106.
- Zahur, R. & Calabrese Barton, A. (2002). Science education for empowerment and social change: A case study of an urban teacher educator in Pakistan. *International Journal of Science Education*, 24(9), 899-917.
- Zeichner, K. (2003). The adequacies and inadequacies of three current strategies to recruit, prepare and retain the best teachers for all students. *Teachers College Record*, 105, 490-519.

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