Chapter 38
On Knowing and US Mexican Youth: Bordering Science Education Research, Practice, and Policy

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The USA shares a 2,000-mile border with Mexico. Across this border Mexicans have been moving for more than 100 years in an exchange of manual labor for economic opportunity. Because of this historical transnational connection, the lives of Mexican immigrants, even before they arrive, are enmeshed with those in the USA. More than half of adults in Mexico, in fact, have relatives in the USA. These relatives send portions of earned US wages back to Mexico in an amount that exceeds US$13 billion (Rumbaut 2006). The immensity of this transnational connection, therefore, is not to be underestimated with respect to its implications for science schooling. US Mexican[1] students study science against the context of extended family's economic dependence on their work and, by extension, their work-related knowledge and skills. Given that Mexicans are the largest Hispanic immigrant group by far – in the year 2000 they outnumbered all European and Canadian immigrants and all Asian, African, and Middle Eastern immigrants combined (Rumbaut 2006) – it is crucial to assess how much science education researchers attend to and know this transnational context and its role in the antecedent conditions, processes, and outcomes of US Mexican science teaching and learning.

Shadowed Science Learning Lives

For the first phase of my literature review on US Mexican science education, I conducted an online search of relevant articles published in selected science education research and teaching journals over the 10-year period of 1998–2008. I

[1] 'US Mexican' refers to persons of Mexican descent, whether foreign- or native-born, living in the USA.

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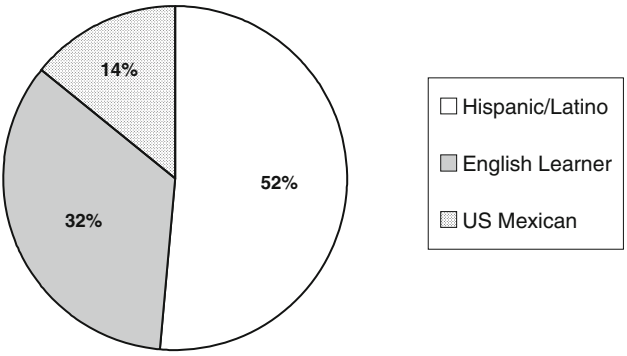

Fig. 38.1 Distribution of populations represented in selected science education journal articles, 1998–2008 (Selected journals include *Cultural Studies of Science Education, International Journal of Science Education, Journal of Research in Science Teaching, Journal of Science Education & Technology, Journal of Science Teacher Education, Life Sciences Education, School Science & Mathematics, Science & Children, Science Education, Science Scope, Science Teacher*, and *Science Teacher Education*)

used, first, the descriptors "Mexican," "US Mexican," "Mexican American," and "Mexican Immigrant" to locate articles explicitly about or involving this target student population. When this search retrieved very few (and often zero) such articles for each journal, I then used the broader descriptors of "Hispanic," "Latino," "English Learner," and "Language Minority" to search again. This substantially increased the number of retrieved articles. In reviewing this expanded pool, if I found explicit reference to US Mexican students I then included those among my target articles. I counted only research and teaching articles directly reporting on specific student experiences and contexts. This excluded literature reviews or position papers.

The results of this phase of the review process indicated an overwhelming slant in published science education articles toward populations described as Hispanic/Latino (36 articles) or English Learner/Language Minority (24 articles). Articles explicitly about or involving US Mexicans (10 articles) constituted only 14% of this subset of published research. The total distribution of articles across these populations is represented in Fig. 38.1.

For reasons described below, US Mexicans are a significant presence in US society. While research on Hispanics/Latinos and English Learners/Language Minorities can include US Mexican populations, the degree to which this ethnic group is not explicitly named as the center of scholarly efforts may indicate that they live in the shadows, so to speak, of science education's collective attention.

Out of the Shadows: Toward a US Mexican Focus in Science Education Research

While falling under the panethnic classification "Hispanic,"[2] Mexicans have a unique relationship with the USA because of issues related to size, status, proximity, and history. In 2000, persons of Mexican origin accounted for 63% of all US Hispanics (Rumbaut 2006). It is estimated that more than half of all Mexican immigrants in the USA have undocumented status (Passel 2004). These size and status issues of US Mexicans are related to Mexico's proximity to the USA as the countries share a long border that, despite US deterrents, facilitates ongoing attempts at illegal crossings. The Mexico–US border is a historically contested space, especially in the US Southwest where some Mexican families have roots that predate the annexation of land that occurred in 1848, as a result of the Mexican–American War. Because Mexican workers have filled US shortages, via official or unofficial labor importation, since before the turn of the nineteenth century, many Mexicans have long family histories that connect them to the USA.

Given the sheer size of the US Mexican population, the contextual information surrounding their schooling takes on particular significance. As Rubén Rumbaut (2006) writes: "[I]t should be underscored that aggregate statistics for the total Hispanic population reflect the predominate weight of the characteristics of the Mexican-origin population" (p. 33). In other words, research about US Hispanics is likely, without saying so, to reflect a more particular US Mexican experience. This particularity is likewise obscured by science education data collection and reporting efforts that take Hispanics, in aggregate, as their unit of identification. It has been acknowledged by the National Science Foundation itself that the goal of broadening the participation of underrepresented groups in Science, Technology, Engineering, and Mathematics (STEM) is not advanced by the aggregation of data without regard to ethnic subgroup (National Science Foundation 2004).

The particularity of the US Mexican experience is reflected in similarly particular educational antecedents, processes, and outcomes that such aggregated approaches to data collection, analysis, and reporting necessarily overlook. For example, while Hispanics, in aggregate, have the lowest rates of educational attainment of all US ethnic minority groups, it is US Mexicans who fare most poorly (US Census Bureau 2002). One explanation is found in the fact that foreign-born Mexicans have the lowest educational levels of any Hispanic subgroup and thus, in addition to challenges posed by English literacy, are less prepared to assist their children with the curricular demands of schooling. Additionally, limited experience

[2]While 'Hispanic' and 'Latino' are often used to denote the same ethnic categorization, they carry different sociohistorical connotations. Of the two, research on self-identification preferences reveals a 3 to 1 preference for "Hispanic" (National Research Council 2006, p. 4); for that reason, I use it throughout the remainder of the chapter.

with schooling also affects the way that US Mexican parents play a role in educational decision-making regarding their children. Anthony Bryk and Barbara Schneider (2002) report that US Mexican parents are more likely to defer to teachers and administrators, rarely questioning judgments made about their children.

The reality of low educational attainment as an antecedent condition among Mexican-origin families fuels teachers' low expectations for this student group influencing all aspects of educational processes. For example, US Mexican students report being happier and living up to their expectations when not with their teachers (Csikszentmihalyi and Schneider 2000). In fact, US Mexican high school students are more likely to believe that their teachers have unfavorable thoughts about them than are other ethnic groups (Schneider et al. 2006).

In terms of schooling outcomes, national performance data indicate that US Mexicans tend to score the lowest on 4th, 8th, and 12th grade tests of reading and mathematics (US Department of Education 2003). US Mexicans are least likely to take college entrance exams and apply to college (Fry 2004) with only 4% US Mexicans taking the Scholastic Achievement Test (SAT) in 2001 (College Board 2002). The dropout rate for foreign-born 16–19-year-old US Mexicans is nearly 40%, the highest of all Hispanic immigrant subgroups. While that rate drops considerably among the native born (to 15%), it still exceeds other Hispanic peer groups (US Department of Education 2000).

What is most striking about US Mexican student achievement is the observation that gains made in performance from the first to second immigrant generations do not carry into the third generation. For example, first- and third-generation US Mexicans start kindergarten with lower mathematics skills than do second-generation students and the pattern does not change over time (Reardon and Galindo 2003). This is surprising given that the third generation is characterized by higher levels of cultural assimilation. The presumption, then, that the poor educational attainment of US Mexican youth is due to a language barrier and, by extension, that attainment will be primarily enhanced by linguistically responsive instructional efforts is naive. It is this very presumption that drives the aggregated category of "English Learner" that also dominates science education research.[3] But, in fact, data on linguistic assimilation illustrate a trend toward a preference for English such that at the age of 24, 87% foreign-born and 96% native-born US Mexican youth indicate a preference for English (Rumbaut 2006). So it is not necessarily an inability or unwillingness to speak or learn English that is causing the regression in educational attainment levels in the US Mexican third-generation population. Researchers surmise, instead, that these parents and their children, having spent more time in US society and schools, could have become disillusioned with education as a path to social mobility (Padilla and Gonzalez 2001). It is this possibility that science education researchers need to more squarely address through curricular and instructional reform.

[3]The immense variability within the English Learner population leads Richard Duran (2008) to state that "ELLs are not a true demographic population… [They] are in effect a policy construction, a category of students established by individual states to satisfy their education laws" (p. 300).

Bordering Science Education Research

An examination of the articles I located explicitly about or involving US Mexican students reveals the current topography of science education researchers' attention to this important ethnic subgroup. The scope of these articles suggests the relevance of a Multiple Worlds model when it comes to research on US Mexican experiences in science schooling.

The Multiple Worlds model, proposed by educational anthropologist Patricia Phelan et al. (1991), has been used to explain differential outcomes in the schooling of adolescent youth (Fig. 38.2). The authors found that similarity between the cultural values and norms of family, school, and peer domains (students' "multiple worlds"), or significantly, students' employment of strategies to put themselves at ease despite the differences between these worlds, helped explain success. With respect to science education, Glen Aikenhead and Olugbemiro Jegede (1999) took up Phelan et al.'s work, concurring with their assertion that it is possible and desirable "to identify institutional structures that operate to facilitate boundary crossing strategies and do not require students to give up or hide important features of their lives" (p. 246). To do this requires understanding US Mexican students' experiences in, and border-crossing between, their multiple worlds.

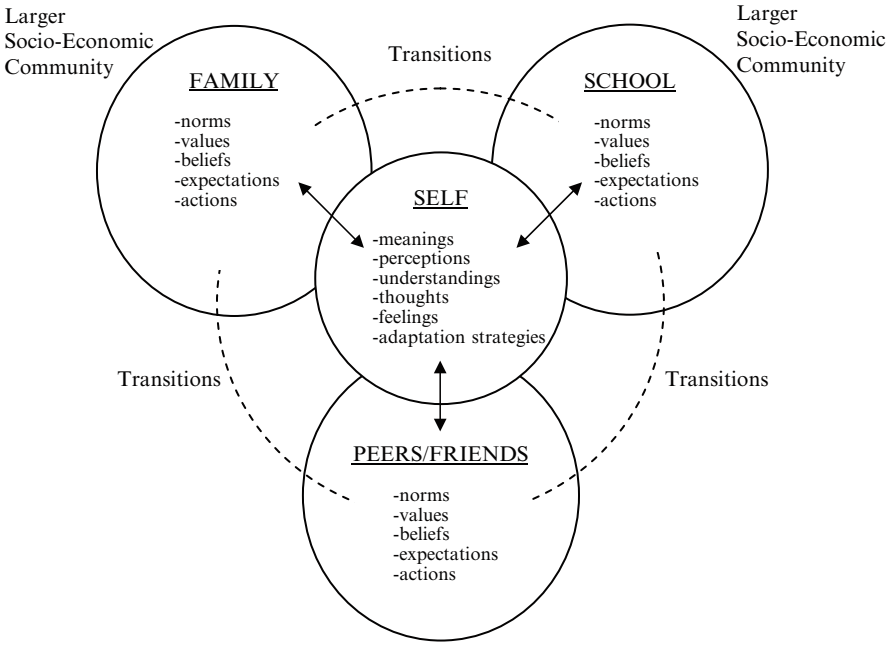

Fig. 38.2 A model of the interrelationships between students' family, peer, and school worlds (Phelan et al. 1991)

Socioeconomic Communities: The Backdrop of Poverty and Agriculture

As illustrated in the Multiple Worlds model, students navigate their movements across family, school, and peer contexts against the backdrop of the larger socioeconomic communities from which they come and in which they live. As attested to in several of the articles, the socioeconomic backdrop of poverty is one against which many US Mexican students experience science education.

For example, my colleagues and I (Richardson Bruna et al. 2007) describe a very small town in rural Mexico that is the immigrant-sending community to a specific immigrant-receiving community in the Midwestern USA. Only through this transnational capital flow (human and financial) have families in Pueblo been able to build several-roomed homes made from fabricated concrete bricks, as opposed to single-roomed handmade dirt ones, to pipe in fresh well water, and enjoy something more than a subsistence diet. Schools have yet to benefit much from the community's new resources and lack features standard to science schooling on most US campuses: certified teachers, fully-functioning media centers, print-rich environments, and textbooks. We explain that, because of this material context of poverty, newcomer students from this rural Mexican community and others like it will not be adequately prepared for the expectations of inquiry-based instruction, Internet research, and print-based information retrieval that typically characterize effective science instruction.

The poverty of such communities in Mexico is, of course, the reason for immigration to the USA. However, in coming, the driving condition of poverty is not always left behind. Angela Calabrese Barton (2001) and Richard Kozoll and Margery Osborne (2004) provide accounts of poverty in their ethnographic case studies of US Mexican students' science learning.

Most pointedly, Calabrese Barton (2001) writes of her work with two elementary-aged US Mexican girls who were living in a homeless shelter in Texas 5 years after immigrating. From her work, we learn that Claudia and Maria were aware of economic disparities between themselves, their peers, and their teacher. These disparities manifested themselves in tensions over expectations for participation in science, in this case, the teacher's expectations that the girls bring a shoe box to school for a shoe box camera. The girls expressed frustration that not only did they not have an empty shoe box at home (the expectation that they had one implies the ability to buy new shoes), but neither were they able to go to the shoe store to get one due to barriers involving their mother and what was within her means in terms of transportation, language, and child care. When the teacher offered shoe boxes, asking the girls to earn them by cleaning erasers during recess, they became angry and destructive. Claudia and Maria used this story to explain to Calabrese Barton that they "hate science" and their teacher "does not really care about [them]" (pp. 901–902).

Even into postsecondary schooling, the economic stigma associated with being Mexican in the USA remains a salient aspect of identity. Kozoll and Osborne (2004) share the story of three college-aged (two first-generation and one second-generation)

US Mexican youth who come from agricultural backgrounds. Hector, the one second-generation youth, recounts memories of racism he encountered, in the Midwest, when being followed by salespeople or being accused by his principal of stealing a car stereo. For him, success in school was about proving "we all aren't like that" (p. 163). Science played no role in that success, beyond just taking what was minimally required. He thought it was about "stupid things," asking "I don't need it in my life, for my future, so why do I have to take it?" (p. 163). The two first-generation youth, Clara and Andrea, talk very directly about how, for them, success in schooling meant creating the possibility for lives outside of communities of poverty, of lives without the instability caused by agricultural migration. For Clara, science, though not something she necessarily enjoyed, was a subject that a teacher made more exciting for her through hands-on and socially relevant activities. For Andrea, science was a subject she more actively liked as it was one place in school where she found refuge from social isolation due to socioeconomic disparity. "Through science, I got to know a few people," Andrea remarked (p. 172).

Common to most of these lived accounts of poverty is the history of agricultural work as a prevailing force in US Mexican students' experiences. The contexts from which many Mexicans immigrate are small subsistence farming communities and, in coming to the USA, agricultural work is where they, historically, have found ready employment. If their goal is to stay in the USA they are motivated, as were the students in Kozoll and Osborne's (2004) study, to create lives for themselves that do not involve the field labor of their parents. Even if their goal is to return to their agricultural communities in Mexico, as was the case with a student in one of my own ethnographic studies (Richardson Bruna and Vann 2007), they hope to do so as professionals, not laborers. Agriculture can be then a way to make science relevant to US Mexican students, in relation to either their past or future. As Kozoll and Osborne (2004) write, "[t]he argument could be made that if there is anyone who needs to know biology, chemistry, chemicals, and these 'stupid things' it is a migrant agricultural worker" (p. 163). These authors go on to talk about the lived science knowledge of agricultural workers who make decisions based on tacit understandings of growing seasons, crop timing, and other conditions, as well as the relevance of science knowledge in relationship to agriculturally related conditions, like pesticide exposure.

But my own ethnographic account (Richardson Bruna and Vann 2007) provides a cautionary tale of the thin line to be walked in making science responsive to the socioeconomic lives of US Mexican youth. My colleague and I am critical of a teacher's framing of a pig dissection activity in a Midwestern meatpacking community's English Learner Science classroom as she tells her students that the dissection will prepare them for work on the line at the local hog plant. I problematize the socioeconomic context in that community that would make such a framing possible to begin with and argue that, rather than being responsive, the framing serves to reflect and reproduce the taken-for-granted ethnic and economic segmentation of such low-skilled, low-wage labor. Discerning the difference between cultural responsiveness and reproduction of social and economic hierarchies in linking science curriculum to community contexts will be of utmost importance in effective work with US Mexican youth.

Family: The Role of Informal Educators

Against this socioeconomic backdrop, the learning of science unfolds amidst transitions between family, school, and peer worlds. Two of the articles which I located for this review (Ash 2004; Siegel et al. 2007) shed light on the role of US Mexican families, specifically their family conversations, in informal science learning.

In her research, Doris Ash (2004) examines how one first-generation US Mexican family learns science together as a result of its visits to an aquarium in California. Using qualitative analyses of observations and interviews related to two aquarium visits (six months apart), Ash documents the science thematic content with which the family was most engaged through the aquarium visit (life cycle, predation, animal vs. plant life, and taxonomic relationship), the various meaning-making resources the family used in their engagement (prior knowledge, pictures, objects, the facilitator, gestures, pointing, questioning, use of Spanish and English), and the nature of their recall. She uses the data from the family's conversations over coral to argue that the family was engaged in scientific literacy (distinguishing fact from folklore, accumulating scientific points of view, generalizing across data sets) and in the dialogic and distributed (jointly produced) inquiry and knowledge production that characterizes it. Ash concludes that family interactions in informal settings, like aquaria, can foster complex scientific understandings, troubling what constitutes the everyday, on the one hand, and the scientific, on the other.

Debra Siegel et al. (2007) also document the science conversations of US Mexican families in California, with an eye toward determining the influence of level of schooling on explanatory talk and style of interaction. Siegel et al. observed 40 US Mexican families, classified according to their mothers' high (12–16 years) or basic (3–11 years) level of schooling, as they participated in a sink or float water game facilitated by the researchers in the families' homes. From their quantitative data, they found that parents in the basic schooling group did not significantly differ from parents in the high schooling group in the ways they explained density to their children, nor did coded analyses of interaction (directive vs. collaborative vs. instructional guidance) reveal any significant differences between the basic and high schooling groups.

Both Ash (2004) and Siegel et al. (2007) attest to the active and helpful role that US Mexican families play in children's science learning. Their findings beg the question of how science schooling can leverage these families' already existing knowledge-generating interactions.

School: The Acquisition of Academic Language and Authentic Science Identity

From the informal context of home and family activity, US Mexican youth come to school. Regardless of the active and helpful support they may receive in the course

of their informal science learning, the research suggests they are likely to encounter challenges in meeting the specialized language and identity demands of the science classroom. Two of the articles which I located for this review (Brown 2006; Duran et al. 1998) speak to the nature of these challenges in addition to some strategies used by science teachers to help address them.

Bryan Brown (2006) takes on the access question related to underrepresented high school students and science classroom discourse. As the teacher researcher of an introductory course at large urban school in Southern California, Brown used focus group interviews to explore students' science learning experiences with a specific eye toward the appropriation of science discourse. Six of the 29 students in his study identified as US Mexican. Brown documents US Mexican students specifically commenting on the helpfulness of the hands-on nature of their science learning. According to them, some people just learn better by "seeing things and stuff" (p. 111). He also shares US Mexican students describing how, in science, "we use a different language basically" (p. 116) and how this different language marks scientists as special. As one US Mexican student remarks, scientists use this different language "to put them at a certain level" (p. 117). These students continue to explain that this results in conflict for them because the specialized language increases the difficulty of science. "[T]he language to me is the hard part," one student says (p. 119). Brown argues that the science education community must adopt theoretical and pedagogical perspectives that help students and their teachers address this specific challenge.

Bernadine Duran, Therese Dugan, and Rafaela Weffer (1998) document their work implementing the very kind of theoretical and pedagogical changes advocated by Brown. They describe a special Saturday enrichment program for underrepresented high school students, the majority US Mexican, in an urban Midwest setting. Because of their initial findings related to difficulties these students had in identifying, expressing, and using key science content, the authors implemented a three-sequence change in instructional practice. In the first or receptive phase of instruction, the authors used diagrams to help students identify target content and ventriloquate or mimic, teacher talk. In a more expressive phase of instruction, students were encouraged to use concepts for their own purposes. In the final, more interpretative phase of instruction, students analyzed real-life experience using acquired conceptual resources with the aim of displacing the teacher's science authority with their own responsibility for science meaning-making. The authors' work suggests that US Mexican students do benefit from approaches to instruction that explicitly attend to the ways a configuration of particular linguistic resources construe particular meanings in science.

While not attending to science discourse per se, Irene Rahm, John Moore, and Marie-Paule Martel-Reny (2005), in their work with a community-based science program for first-generation students, describe how the authenticity of hands-on science learning provided in a biochemistry lab resulted in an enhanced science identity for US Mexican student, Edric. As opposed to the quick experiments of science classrooms, the mentorship in the lab allowed him to see that science is about confronting and resolving unanticipated problems. As he worked with a team

to improve a pain-relieving drug, Edric came to understand science within its larger social context and to connect himself personally to the outcome of his science activity. Expressing how he would feel if the drug were to make it out onto the market, Edric comments on his "bragging rights" and how "that'd be cool" (p. 6). This resonates with what Calabrese Barton (2001) found in her work in the after-school science program. The same girls, who expressed being alienated by their science learning in school, developed an expanded sense of science agency when encouraged to experience science learning in genuine relationship to their lives' concerns. Work that began with a simple biology-based caterpillar project evolved, out of student interests, into something more akin to architectural engineering. Calabrese Barton documents how the youth she worked with navigated the constraints imposed on them by their residence within the homeless shelter. They advocated for the construction of movable planters that would allow them to move the butterflies to an acceptable outside location once they emerged and were no longer allowable inside. In the case of one youth, she also advocated for the building of a desk from the planter material, at which she could study (since she did not already have one). Calabrese Barton describes the youths' activities as providing them with a transformed understanding of the meaning of science learning and identity, mentioning particular measurable outcomes such as the application of concepts such as scale, measurement, and spatial relations all in service of their own life-based objectives.

Taken together, these articles clearly indicate the need, within science education, for explicit attention to the challenges posed by academic language to US Mexican students. Similarly, given what these articles suggest about the distance students experience between themselves and science discourse and practice, efforts to target academic language acquisition should be contextualized within meaningful hands-on activity so that the relationship between specialized language resources and the respective uses to which they are put in science is authentic and not artificial.

Peers/Friends: Relationships in School and Science

While not centrally treating the theme of peer- and friend-group involvements and their implications for science learning, several of the articles I located for this review provide insight into the ways in which these relationships may significantly influence, in positive or negative ways, science schooling outcomes for US Mexican youth. Kozoll and Osborne's (2004) interviews with the three students in their research attest to the extent to which they made sense of their schooling experience as unique when considering the high dropout rate among their US Mexican peers, friends, and, indeed, family; as one of these students, Hector, said in referring to his experience in Texas schools: "[N]ot that many people graduated so that's why I stood out" (p. 162). This same student goes on to explain that his success in school was motivated by a desire to disprove the stereotypes associated with his ethnic group: "They think all Mexicans are on welfare and they all have low paying jobs and they're uneducated and that's not true" (p. 163). The story of another of these

students, Clara, speaks to the importance of extracurricular activities and, by extension, their associated peer groups, in providing her with opportunities for relationships with people very different from those of the community from which she came, opportunities she readily embraced. On the other hand, Andrea speaks to the real challenges posed by socioeconomic differences between her and her peers in school. But, for her, these differences were somewhat leveled through the shared activity of inquiry that the science classroom provided.

The formation of these kinds of academic, social, and intellectual identities among university engineering students in California who were women of color, and among them those of US Mexican heritage, was the subject of a study by Erika Tate and Marcia Linn (2005). Using an interview-based methodology, these authors found that the institutionalized STEM-oriented peer support networks offered by the university were helpful in the early years of college. However, in all cases, they did not completely satisfy students' social needs. Students reported on the importance of their participating in social groups consisting of members with shared racial/ethnic identification. The salience of racial/ethnic identity is clear when a US Mexican student comments on the difference between her high school and university environments: "My high school's like 99% Mexican. So, I come here and it was very different… it was hard to interact with Asians or Whites because I wasn't used to it" (p. 488). The authors note that this implies that both official academic peer networks and more informal ethnic peer organizations have equal roles to play in promoting persistence among underrepresented students on college campuses.

Two of the articles provided a glimpse of what peer/friend relationships actually look like when enacted within a science-learning setting. From Calabrese Barton's (2001) work, we see how one way that Maria and Claudia understood their friendship was through their shared dislike of science. It was their "secreto de las niñas" [girls' secret] (p. 900). These girls found communion in their shared socioeconomic positionings as science outsiders in not being able to comply with the teacher's shoe box request. In protest of such positionings and to let the teacher know of their dislike for science, these girls, as Calabrese Barton describes, consciously decide not to raise their hands in class. It is to transform the meaning of science and as a result their science learning identities that Calabrese Barton engaged these girls and their peers in the more authentic activities of her after-school program. Ultimately, she argues, their expanded science-learning agency needs to be understood within the expanded sense of individual agency, as persons acting within and on the world, that participation in an authentic community of science practice afforded.

The story of Claudia and María resisting the camera shoe box science activity because of their marginalizing positioning finds a parallel, again, in my own account (Richardson Bruna and Vann 2007) of high school English Learner Science students' reluctance to do the meatpacking-framed pig dissection. While not as explicit about a conscious intention to withdraw from class activity, the authors' my account shows newcomer students clearly expressing disinterest not only in participating in the dissection activity but in the teacher's framing. In addition to his peers' more subtle expressions of displeasure, one student, Juan, flatly states, "Yo no carnicero [I'm no butcher]" (p. 42). As the activity proceeds, the account also shows other

peers' different ways of taking up the teacher's framing; these students talk amongst themselves about their work as butchers in Mexico and jokingly compare their dissection work to the preparation of traditional pork-based Mexican dishes. One student, Augusto, goes to great lengths to make the teacher aware of his extensive knowledge of pigs, gestation, and miscarriage from his life in Mexico, work he hopes to continue through continued agricultural studies that can benefit his community. I assert it is, in fact, Augusto's insistent counter-example to the teacher's initial framing of the pig dissection as relevant to his life in ways far beyond that of his family's work at the meatpacking plant, which ultimately leads the teacher to provide him and his peers with a more authentic science framing for the activity. That eventual framing concludes that body systems are complicated, that animal dissections allow us to learn more about them, and that there are ethical questions surrounding their use. In this way, I, like Calabrese Barton, document the way in which peer groups react to science classrooms as places that reproduce, within their walls, the hierarchies of the larger society, while also pointing to how peer groups can play supportive roles in trying to create different science learning places premised upon different social positionings.

On Knowing and US Mexican Youth

The quantitative results of my research review suggest the paucity of efforts, within the field of science education, to know about the particular learning experiences of US Mexican youth. Given that US Mexicans are the largest nondominant ethnic group in the nation and that 42% of them are under the age of 20 (Durand et al. 2006) and thus theoretically in school, this indicates that the field does not currently have the capacity to effectively address the curricular and instructional needs of many teachers and students. The directions future research efforts should take clearly emerge, however, from the qualitative review. As suggested by the Multiple Worlds model, the science learning experiences of US Mexican youth are configured across a variety of informally and formally based relational domains, each providing its own set of challenges and resources. Science education researchers would do well to attend to each of these domains, explore their interconnections, and comprehend how they construe particular ways of science knowing and activity. While the same is true of every science learner's experience, it is critical to pay concerted attention to the particularity of the US Mexican experience as part of efforts to increase access to and representation within the sciences because of the societal implications of their continued poor performance.

As Rubén Rumbaut (2006) points out, 69.7% of Mexican-born workers labor in the lowest paid jobs of the US economy. This situation, he continues, "has profound implications for the social and economic prospects of their children's generation, and it is also the basis for common stereotypes that disparage and stigmatize the population as a whole" (p. 58). Science education has a crucial role to play in reworking this current social arrangement by redistributing science knowledge,

identity, and socioeconomic power. What Patricia Gándara (2006) says about the societal benefits of higher education is true for science: "When [science] education is curtailed for a population group because of systematic impediments to their intellectual advancement, then both the individual and the society are impoverished" (p. 235). Dismantling these impediments, these borders to opportunity, will require science education researchers to do some border crossing of their own – away from their work with more familiar populations and domains and into new worlds, both in the US and Mexico, of student communities, classrooms, families, friends, and peers.

Such work promises to advance theoretical and methodological approaches to knowing US Mexican youth in ways that have important political and pedagogical payoffs. For example, researchers are learning more about the validity and reliability limitations of such standardized tests when used with culturally and linguistically nondominant students. There is growing evidence demonstrating systematically varied heterogeneity in performance among EL groups, suggestive of an interaction between the test and the knowledge and skills associated with particular ethnic backgrounds (Duran 2008). This is a potent example of the way in which discerning the particularity of the border crossings made by US Mexican youth into school science will become increasingly particularly important.

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