Chapter 6
Frameworks for Examining the Intersections of Race, Ethnicity, Class, and Gender on English Language Learners in K-12 Science Education in the USA

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> After observing one section of the biology class for a week, I [Sonya] approached the biology teacher and student teacher about the table of three Asian students seated at the back of the classroom. I had sat with the students for one week, observing their interactions with one another while engaging in small group activities focused on understanding the function of different cell organelles. It had come to my attention that the two male students in the group did not speak the same first language, making English their only common language. The third student was a native English speaker and did not speak a second language at home. When I asked the biology teacher why she had grouped the three students in this way, she indicated she believed they could all "talk to and help one another in their own language." Upon sharing with the teacher that two of the boys were Vietnamese and Cambodian and did not speak the same language and that the third boy was Chinese American and only spoke English, she expressed surprise, noting she did not really know what [ethnicity] "any of [her] students are." (January 2010, *Field Notes and Interviews, High School Biology Teacher, Philadelphia*)

According to the Census Bureau's 2008 *American Community Survey*, there are nearly 38 million foreign-born immigrants residing in the United States of America (USA), representing about 12.5% of the total population. The children of immigrants in the USA represent the fastest growing student population in K-12 classrooms,

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and the majority of these are language minority and/or English language learner (LM/ELL) students.[1] The vignette above provides an example of some of the inherent social, linguistic, and pedagogical structures in science classrooms that can inhibit ELL students' agency as learners (Wassell et al. 2010). Currently, researchers know little about the learning needs, achievements, or problems of LM/ELL students and their families, especially with regard to science education. As science education researchers, we conduct research on K-12 school science experiences to improve teaching and learning for LM/ELL students. Because we recognize that multiple factors, such as gender, race, ethnicity, class, religion, country of origin, native language, and school experiences in the country of origin, collectively shape student and teacher experiences, we contend that researchers should use comprehensive measures for making sense of the ways in which these categories intersect in the classroom.

In our work, we argue that through the use of two complementary theoretical frameworks, intersectionality and cultural sociology, researchers can gain multifaceted understandings about the challenges teachers face in trying to meet science content standards while supporting the learning needs of LM/ELL students. In the sections that follow, we briefly describe how we are utilizing these frameworks to expand our understanding of the complexities of the teachers' and students' individual experiences in school science. In an effort to illustrate some of the challenges facing researchers examining these issues, we draw from some preliminary findings from research conducted as part of our work with in-service middle school science and English as second language (ESL) teachers[2] and their students in two urban K-8 schools.

Integrating Frameworks to Expand Levels of Analyses

Because our research is grounded within a sociocultural theoretical framework (Sewell 1992), we emphasize the dialectical relationship between the individual and the collective in our utilization of intersectionality as an analytical tool.

[1] In the United States, the term language minority (LM) is used to describe students who live in homes where a language other than English is the primary language spoken. English language learners (ELLs) are language minorities who have been identified as having limited proficiency with spoken and written English. Both LM and ELL students are often constructed as cultural "others" in K-12 schools in the USA. In this chapter, we use the term LM/ELL to refer to all students who may benefit from English language supports in schools and who may be challenged as learners as a result of their limited English language proficiency. We recognize that there are major differences in the needs and experiences of ELL and LM students, yet for the purposes of this chapter, we contend that both groups need additional supports in classrooms to make science academic language comprehensible and to meet science standards. In addition, we acknowledge that there is also a need for research to be conducted on the experiences of students who speak a nonstandard dialect of English (e.g., African American Vernacular English or Southern American English) who can also be disadvantaged in school science in the USA by their limited proficiency in standard American English, especially in speaking and writing.

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As such, we view the individual|collective[3] as inseparable, meaning we cannot look at the individual without considering the collective and the relationship of the individual to, and with, others. To that end, it is critical to examine the impact of globalization and migration on individuals and groups of people (a collective), especially in the context of education, including science education. We see intersectionality (McCall 2005) as being a complementary methodological and analytical framework to cultural sociology, especially when considering how global trends in migration inform teacher and student experiences in K-12 school science in the United States. Intersectionality provides a powerful lens with which to contextualize the complexity of issues science education researchers must contend with when attempting to draw generalizable conclusions about immigrant students' needs and science learning experiences. And as such, it enables researchers to problematize the consequences of the simultaneous interaction of systems of oppression, such as gender/gender identity, race, ethnicity, religion, class, sexual orientation, nationality, and language.

For example, currently, LM/ELL students are typically characterized in the research literature using broad labels, such as "English language learner" or "Asian" or "Hispanic," with little attention paid to the complexity of the multiple yet intersecting aspects within their identities. Without the ability to disaggregate data based on differences in languages spoken, gender, race, ethnicity, religion, etc., it is difficult for researchers to gain a comprehensive understanding of the challenges faced by LM/ELL students and their teachers in the context of K-12 school science. Research in science education that utilizes sociocultural theoretical frameworks for data collection, analysis, and interpretation highlights and shows the importance of taking into consideration the multiple categories of students' identities.

However, to better illustrate the complexities of teachers' and students' individual experiences in school science from the perspective of intersectionality, we also need to understand the effects of globalization at different levels of analysis, namely the macro, meso, and micro levels. In doing so, we can contextualize our research and highlight some of the significant challenges faced by science teachers with regard to knowing and understanding their students as learners. We begin this chapter by offering the reader macro, meso, and micro level perspectives from which we can examine the impact of global migration patterns on K-12 science education in the USA.

[3] We placed the Sheffer stroke (|) between two words or a prefix and a word to indicate the existence of the various states of being (on either side of the Sheffer stroke) as constituting a whole. The Sheffer stroke is used to denote a both|and relationship between two concepts as a way to help conceptualize the complexity of the relationship.

Global Trends in E|im|migration[4] at the Macro Level

There is a growing body of literature examining the impact of globalization on economics and politics (Clothey et al. 2010), and research is beginning to emerge discussing the implications of globalization on education, specifically its impact on K-12 science classrooms (Carter 2008), science teacher education (Richardson Bruna 2010), and/or science education research (Martin 2010). Being able to make sense of the ways in which immigration trends to the USA are being shaped by macro level forces allows researchers and educators to better understand the impact on the regions to which people are migrating, including the neighborhoods where the children in these families are learning school science. In our consideration of the dialectic relationship between the individual and the collective, in the following section, we provide a brief introduction to global migration patterns (that is, a macro level analysis of groups of people moving within countries and around the world) to better understand the impact of migration in the context of globalization in K-12 education in the USA. Herein, we provide a brief description of internal and international migration patterns in East and Southeast Asia[5] and Latin America[6] to provide some historical context for the immigration patterns of people to the USA over the last century since these regions currently serve as the largest providers of e|im|migrant students to K-12 schools in the USA.

In recent decades, there have been unprecedented numbers of people migrating, both within a given country and from country to country, in search of labor opportunities. Worldwide, there are currently an estimated 214 million international

[4] Just as we introduced the concept of the dialectic relationship between the individual and the collective, we also use the Sheffer stroke to indicate that the process of leaving one's homeland for another country as a migrant is complex. The term e|im|migrant recognizes that immigrants to a new country are simultaneously emigrants from their native country. We prefer this term as one that is more inclusive of the complex nature of migration and because the term "immigrant" often has a negative connotation in the new country. The Sheffer stroke enables us to represent the act of emigrating from a host country, migrating to a new country, and becoming or being an immigrant in a new country.

[5] For the purpose of our research, we define East Asia as the region including the countries of Hong Kong, Japan, Macau, Mongolia, People's Republic of China, Republic of China (Taiwan), and the Republic of Korea. We define Southeastern Asia as the region including the countries of Brunei, Burma (Myanmar), Cambodia, East Timor (Timor-Leste), Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand, and Vietnam. Our research of the literature focused on East Asia, Southeast Asia, and Latin American regions.

[6] In our research, we use the term Latin America to refer to regions in the Americas where the Spanish or Portuguese languages are spoken, namely Mexico, most of Central and South America, as well as the Caribbean, Cuba, the Dominican Republic, and Puerto Rico. When referring to student groups in this chapter, we use the term Latino/a instead of Hispanic to be inclusive of students who may identify culturally/racially/ethnically as being Latino/a but who do not speak Spanish (e.g., Brazilians speak Portuguese and can be characterized as Latinos/as but could not be classified as Hispanic). When we use the term Hispanic, it is in reference to terminology utilized by the US Census Bureau.

migrants, who represent just over 3% of the global workforce (International Organization for Migration [IOM] 2010). Migration patterns include both the internal movement of people within the borders of a country and the movement of people across borders of adjacent countries or countries that are geographically distant. Internal migratory flows can be diverse and complex in terms of duration (seasonal or permanent), composition (e.g., women only, children only, or only ethnic minorities), and direction of flow (e.g., rural to rural, rural to urban, or urban to urban). In many developing and developed countries, the majority of international migration occurs as border migration, meaning individuals cross from one developing nation to another for short-term work, such as from one country to another in Southeast Asia, or from developing to developed nations, such as from Mexico to the United States (World Migration Report [WMR] 2008).

Currently, the largest human migration trend involves internal movement of people from rural to urban centers. Some examples from East and Southeast Asian countries that have seen significant rural to urban migration include the People's Republic of China, Mongolia, Cambodia, and the Republic of Korea. In China alone, there are more than 150 million Chinese migrant workers (WMR 2008). The migration pattern in China is described as circular because migrants move from rural areas to find work in garment and industrial factories in the cities and then return to the countryside (for many, only once per year) to visit their families. Researchers estimate around 70% of these Chinese migrants are between the ages of 16 and 35 and will spend years, or even decades, in this circular migration pattern before returning home to retire (WMR 2008).

Cambodia is another example of a country with a large internal migrant population. In recent years in Cambodia, there has been a sharp increase in rural-urban migration, about 35% of the population, including many young girls and women who seek work as unskilled labor in garment factories, as domestic help, or as sex workers (WMR 2008). Other regions, including Latin America, have different migration patterns. Faced with dwindling rural populations, urban-urban migration patterns in this region have steadily increased since the 1980s. For example, in Mexico between 1995 and 2000, nearly 70% of all internal migration was between urban areas. Some regions in Latin America have lost large portions of their population to external migration. Some countries in Latin America have more than one-tenth of their population living abroad as e|im|migrants (WMR 2008).

In the context of K-12 education, research examining the experiences of families with children who are e|im|migrating (both legally and illegally) to and from other countries may offer findings that have important implications for educational policy and teacher practice in both the host and sending countries. Much of the research on immigration to the USA has focused on understanding the processes of assimilation and enculturation of e|im|migrants into American society. Many accounts of individual e|im|migrants' experiences in the USA at the turn of the twentieth century have been construed by historians as being representative of the experience of the collective group, regardless of race, ethnicity, gender, class, etc. As a result, research into these historical accounts may provide some general understandings about the plight of subgroups of European immigrants, such as the "Irish" or the "Italians," but there

are few accounts of the experiences of individuals who comprise these larger groups, such as unmarried Irish women who e|im|migrated as indentured servants at the turn of the last century. Findings from studies such as these speak to the need for educational researchers to consider the impact of migration and globalization not only on large groups of people at the macro level but also at the meso and micro levels as well. The importance of recognizing and appreciating the experiences of individual e|im|migrants and members of ethnic subgroups is emerging as a significant area of research within many fields of global study.

Technological advances in communications, including widespread access to the Internet and mobile phones, offer today's e|im|migrants close interaction with their family and friends, regardless of where they live. These tools are contributing to the establishment of transnational global networks that support circular, cross-border migration patterns (Portes 2001). Thus, unlike any time in the past, people are migrating to new lands but are maintaining familial relationships, economic ties, and national allegiance to their sending countries. As a result of improved communications and transnational networks, when people e|im|migrate from one country or region to another, they can more easily locate and develop concentrated communities within new host countries. For example, in the United States, Mexican-born e|im|migrants account for about 30% of all foreign-born immigrants, and many of these migrants reside in large homogeneous Mexican American communities. Over the last decade, researchers have studied such communities to understand how "global villages" help e|im|migrants find jobs and accommodations, circulate goods and services, and gain access to social and economic information (Vertovec 1999).

These communities and migration patterns have important implications for K-12 education systems as the children of these families are more likely to remain immersed in both their native culture and language while also being asked to assimilate the host country's cultural norms and language. Natalia Martínez-León and Patrick Smith's (2003) recent study examining the assimilation and enculturation processes for *retornados*, transnational migrant families, and children who move to and from New York City and Puebla, Mexico, found this circular migration pattern had a significant impact not only on student learning but also on the teachers and communities in the New York City and Puebla schools. Their study revealed that teachers in the receiving schools in Mexico did not have the necessary resources to support the further development and maintenance of English language skills of the transnational learners, especially at the elementary school level where English instruction was absent. Additional research highlights the difficulties faced by immigrant children as science learners in classrooms where teachers have limited language resources, other than English (Richardson Bruna and Vann 2007). Building on this work in a more recent study, Katherine Richardson Bruna (2010) explored more closely the challenges Mexican transnational children face as science learners when their teachers fail to inquire about prior educational histories. Richardson Bruna argued that if teachers hold a limited grasp of the socio/historical/political/cultural context of global forces that impact the lives of transnational e|im|migrants, then they remain ill equipped to recognize and value the science educational experiences children bring with them from schools in their native countries and from their encounters with science in their everyday lives.

Such findings not only make clear the need for teachers to acknowledge the importance of e|im|migrants' experiences as individuals but also demonstrate a need for educational research utilizing intersectionality and cultural sociology as theoretical lenses so researchers can better understand and explain how migration is affecting science teaching and learning from the perspective of both individuals and collective groups of people. In the following sections, we focus our analysis from the macro level perspective to examine demographic trends in the USA to illustrate at the meso level how K-12 education in the USA is being impacted by e|im|migration of individuals from the regions previously discussed in this chapter, namely East Asia and Latin America.

A Meso Level Analysis: Who Are ELLs and What Challenges Do They Face in the USA?

Nearly half of all ELL students in the USA are native born, including the children of immigrant and/or refugee parents, Native Americans, and US Latinos/as (Capps et al. 2005). Almost three-quarters of all foreign-born ELLs have resided in the USA for less than 5 years (31% for less than a year and another 41% for 1–4 years), and many of the remaining long-term ELL students are still not English proficient (Garcia et al. 2008). US ELL students speak more than 460 languages; however, Spanish is spoken by 75% of all ELL students (Kindler 2002). After Spanish, the second most common language is Mandarin Chinese (4.4%) (Migration Information Source [MIS] 2008). Fifty-five percent of e|im|migrants who have lived in the USA for more than 40 years speak a language other than English at home (Singer et al. 2008). Of those who arrived in the USA since the 1990s, 82% speak a language other than English at home. Country of origin plays a significant role in determining English language proficiency as well. Nearly two-thirds of e|im|migrants from Mexico and more than one-half of e|im|migrants from Southeast Asia report not speaking English well or at all. Only about one-quarter of e|im|migrants from the rest of Asia report not speaking English well or at all.

To compound the challenges facing ELL students, approximately 91% of all ELL students live in metropolitan areas (Fix and Passel 2003). More than half (53%) attend schools where more than 30% of their peers are also ELL students. More than 75% of ELL students live in poverty. However, the actual rate may be significantly higher since not all poor families provide the requisite documentation to receive subsidized school lunches; in some cases, this is a result of residing in the country illegally (Zehler et al. 2003). Thus, a majority of ELL students deal with the complex issues associated with urban schools, such as larger enrollments and class sizes, racial and ethnic diversity, student poverty, health problems, and school violence (Noguera 2003). In addition, teachers in urban schools often hold provisional, emergency, or temporary certification; are teaching out of field; and have less academic preparation than their colleagues in suburban schools (Ingersoll 2007).

The USA is a monolingual society; thus, language is a significant factor in a child's schooling experience and in determining an individual's status as "other."

Schools and teachers often support monolingualism as a norm by ignoring linguistic diversity. Cultural adjustment, social exclusion resulting from migration, and linguistic barriers are distinct to ELL students and profoundly intertwined with the process of migration (Louie 2005). Compounding these challenges is the perception that the cultural and linguistic backgrounds of ELL students are not advantageous for their academic success in US schools (Vang 2005). In addition, ELL students and their parents lack the knowledge to successfully negotiate the US educational system (Louie 2005). Further, ELL students' lack of access to and proficiency in English – the dominant language in the USA and the language used in school – negatively affects their ability to gain new content knowledge. Estimates for the time it takes learners to acquire academic English range from 4 to 7 years (Butler et al. 2000) to 10 years for students with weak native language literacy levels (Collier 1987). While learning English, ELL students must also master standards-based content-area learning outcomes and do "double the work" as they study to obtain language proficiency and academic content knowledge (Short and Fitzsimmons 2007). This is particularly problematic when students come to the USA during their middle and high school years, with 6 or fewer years to gain English proficiency and learn the requisite standards in science and other academic subjects to graduate.

These issues may account for the 42% dropout rate for ELL students from school, a number that is significantly higher than that of native English-speaking students (10.5%) (August and Hakuta 1997). Moreover, states with the highest immigration rates and population growth have the highest dropout rates for ELL and minority students (Fine et al. 2007). Furthermore, teachers often hold deficit views of ELL students' abilities (Sacks and Watnick 2006). Fewer than 3% of teachers instructing ELLs have a degree in teaching English to speakers of other languages (TESOL) or bilingual education (National Center for Education Statistics [NCES] 1997).

Unfortunately, none of these reported data is especially helpful for researchers interested in examining the challenges facing individuals who are broadly characterized by labels like "Asian" or "Latino/a." Details and factors such as students' migration experiences, family situation, reason for migrating, or future goals have important implications for teaching and learning in K-12 schools. However, if researchers continue to only adopt macro and meso level perspectives from which to examine the experiences of individuals within these broad groups of people, then it is difficult to imagine how teachers serving these students will be supported to understand the varying needs of the science learners in their classrooms.

In the following section, we share some initial findings from our ongoing NSF-funded study involving LM/ELL students and their science and ESL teachers to offer a micro level perspective of how migration is impacting urban middle school science classrooms in a large urban center in the northeastern United States. By examining micro level migration patterns to the Philadelphia metropolitan area, we are better able to draw connections between international migration patterns and the impact on individual teachers, students, and communities in local contexts. Building from this section, we conclude this chapter by raising some questions related to policy, teacher practice, and science teacher education, which we find critical for promoting the academic success of these growing subpopulations of students in both the USA and in other countries around the world.

Immigration Trends in Philadelphia: A Micro Perspective

Philadelphia's e|im|migrant populations have followed national trends with significant growth in the last 20 years; e|im|migrants now account for 9% of the city's population (Singer et al. 2008). Since the 1970s, Philadelphia has experienced several distinct waves of e|im|migration, both of refugees from Southeast Asia (Vietnam, Cambodia, Laos, and Indonesia), Eastern Europe (the former Soviet states), and Africa (especially Liberia), and of voluntary e|im|migrants from Korea, China, India, Mexico, and the Caribbean Islands (Welcoming Center for New Pennsylvanians [WCNP] 2009). Singer and colleagues (2008) noted that geographical areas in Philadelphia that historically were strongly identified with White European e|im|migrants were now home to great ethnic diversity with a population characterized as Asian (39%), Latin American and Caribbean (28%), White European (23%), and African (8%). The researchers also found that 55% of e|im|migrants age 5 years and older in Philadelphia spoke English "less than very well."

Seen as a viable way to stem population flight from urban centers, cities like Philadelphia have instituted several initiatives to bring e|im|migrants to live and work in the city. Philadelphia's e|im|migrants from Asian and Latin American countries have settled in ethnic enclaves, which are neighborhoods or sections of neighborhoods that are culturally distinct from the surrounding areas in that there are businesses (grocery, clothing, and music stores), restaurants, and places of worship used primarily by the ethnic minorities within that community and catering to specific cultural and language needs. More than 56% of Philadelphia's Chinatown residents, for example, are foreign born from China, while immigrants from Indonesia, Hong Kong, Vietnam, and Guyana comprise about 5% each of the total foreign-born population. Other neighborhoods, such as South Philadelphia, make up the commercial center of a "new Asia-town," catering to Vietnamese, Cambodian, Indonesian, and Laotian refugees. The large numbers of Latino/a e|im|migrants from Mexico and Central and South America reside in the "heart of Mexico."

This growth in the e|im|migrant population in Philadelphia has significantly impacted the demographics of neighborhood schools. For example, the population of Latino/a students at one neighborhood elementary school has more than doubled from 13% in 2003, to 23% in 2008 (School District of Philadelphia [SDP] 2009), to 32.4% in 2010 (SDP 2011). As a result, teachers are increasingly called upon to support ELL students and their families. However, currently, there is little published research focused on providing useful science-specific teaching strategies to help support teachers and the students and families in these changing communities. In an effort to address the learning needs of specific ethnic subgroups involved with the recent waves of e|im|migration to the Philadelphia region, we are conducting a longitudinal research study focusing on two school communities with large populations of LM/ELL students.

In the following sections, we share some findings examining the educational achievement of students within the ethnic subgroups that are most prevalent in Philadelphia urban schools and that are the focus of our research study. These findings provide a context for further exploration of individual LM/ELL students in

Philadelphia and illustrate the need for research combining intersectionality and multiple levels of analysis using cultural sociology as we seek to understand how not only race but also ethnicity, gender, and language proficiency shape the experiences of individual students and groups of students in school and science.

Situating Our Research: Southeast Asian and Latino/a Students in the USA

Overshadowed by the model minority myth that stereotypes all Asian American students as academically successful (Lee 1996), the needs of Southeast Asian American students, particularly ELL students, are often overlooked. Following Spanish, the second and third most spoken languages of ELL students across the USA are Vietnamese and Hmong. Both groups are represented in Philadelphia, which has the third largest Vietnamese e|im|migrant population on the east coast and the fourth largest Cambodian population in the USA (WCNP 2009). Southeast Asians from Cambodia, Laos, and Vietnam are the largest group of refugees in the USA. As recent refugees, many Southeast Asians have no formal education or have not developed literacy skills in their native language due to lack of opportunities for education in war-torn countries and while living in refugee camps prior to resettlement in host countries. For example, in the United States, many Southeast Asian American adults 25 years and older have only a high school degree, and a significant number have no formal schooling, including 27% of Cambodian Americans, 45% of Hmong Americans, 23% of Lao Americans, and 8% of Vietnamese Americans (Ngo 2006). These data represent both immigrants and US-born Southeast Asian Americans.

Latino/a students fair even worse than Southeast Asian students in US schools. Dropout rates for Latino/a students in the USA are significantly higher than for other ethnic groups. Forty percent of Mexican e|im|migrant youth, the largest subgroup of Latinos/as, who arrive in the US between the ages of 16 and 19 drop out of school. Latino/a youth who are born in the USA and who attend US schools for longer periods than those who have e|im|migrated to the USA have a dropout rate of 20%, compared with 8% for non-Hispanic White students (Morse 2005). Additionally, the native-born and e|im|migrant Latino/a population accounted for half of the nation's growth between 2000 and 2006 (US Census Bureau 2006). And native and e|im|migrant Latinos/as represent the single fastest growing ethnic group in Philadelphia (WCNP 2009).

We believe it is significant that much of the national data available to researchers for analysis of educational trends among students of different ethnic groups does not provide information about e|im|migrant status or language proficiency. In our own study, we are examining the educational experiences of students from different ethnic groups with greater attention paid to intersecting sites of oppression, including proficiency in native and English languages. We believe it is critical that we explore the intersections among ethnicity, class, and language proficiency if we are to

understand who these students and their families are and what challenges they face in the community and in the schools.

In our review of the educational research addressing school science experiences of students identified as native born or e|im|migrant Latinos/as, we found no research examining student experience in relation to country of origin, class, region, or language. However, meso level analyses of demographic data describing the current wave of Mexican immigrants to South Philadelphia reveal important findings with regard to differences in the native languages spoken by groups who are e|im|migrating from Mexico. While Spanish is the national language spoken across Mexico, many of the new e|im|migrants to Philadelphia come from central and southwestern Mexico, including the regions of Puebla, Veracruz, and Oaxaca (Saverino 2007). In these regions, large percentages of the population are indigenous peoples who communicate primarily in dialects other than Spanish, such as Nahuan or Nahuatl, which is a language descended from the Aztecs (Pedraza 1996). Providing Spanish language support for families and children in these school communities may be of little help; because the type of demographic information being collected by school and government agencies is rarely disaggregated with enough detail, including language and ethnicity, many of these students are labeled as being "Mexican" and, thus, are assumed to speak Spanish.

This is another example of why it is important for researchers to be able to account for the ethnic and linguistic diversity of e|im|migrants in the US K-12 education system. For students and their families who are e|im|migrating from Asia, Southeast Asia, and Africa, some may speak a primary dialect within their ethnic community or region, a secondary dialect (often a national language) for government and official transactions, and additional dialects necessary for trade and business among members of different regions. Thus, in some K-12 classrooms, science teachers may need to support students who are acquiring English as a third or fourth language, and many of these students may not be literate in any of these languages, including their first language.

Using Intersectionality to Improve Science Teaching for LM/ELL Students

From the normative perspective, intersectionality seeks to unravel the ways in which multiple marginalizations of race, class, gender, or e|im|migration at the individual and institutional levels create social and political stratifications, and thus, requires a multi-method research approach that is attuned to examining the interactions of these different categories (Hancock 2007). Most educational research depicts diverse groups of students using broad labels, such as "English language learner," "Asian," or "Hispanic," without attending to the multiple factors, including gender, race, ethnicity, class, religion, country of origin, native language, and school experiences in the country of origin, that all collectively shape student and teacher experiences at the local levels. The use of such labels is ubiquitous in K-12 classrooms, as is illustrated in the

vignette presented at the beginning of this chapter. In that situation, the teacher assumed that all three Asian students spoke the same language and could provide language support for each other during cooperative science learning activities. This vignette illustrates the possibilities for using intersectionality in K-12 science classrooms as it demonstrates the need for teachers to think critically about the categories represented in their students' identities. Herein, we introduce how we use intersectionality in our research with science and ESL teachers to help teachers better understand their students by applying intersectionality to the introductory vignette for analysis. Building from this analysis, we offer implications for teacher practice in the context of this science classroom.

Intercategorical complexity uses analytical categories to examine relationships between social groups and specifically focuses on inequities and how those inequities exist in multiple and, at times, conflicting aspects. Leslie McCall (2005) proposed three categories – anticategorical, intercategorical, and intracategorical – to understand intersectionality. Anticategorical complexity deconstructs social categories. In our work, we have found that the use of anticategorical complexity provides opportunities for teachers to deconstruct the social categories tacitly assigned to their students. For example, in the opening vignette, the teacher had made broad assumptions about her students' ethnicities, languages, and learning needs based on her perception of their race as a pan-Asian unifying construct. By using anticategorical complexity to examine the students' ethnicities and languages, this teacher could have provided the students a culturally responsive instruction that would meet each student's specific needs by taking into consideration their individual ethnicities, languages, and other social categories. Further, she could have considered the students' cultural differences when learning science, based on their gender, class, and/or religious beliefs.

When using intercategorical complexity as a strategy for intersectionality, teachers and researchers can examine how power dynamics, social location, and other social categories shape identity (Shields 2008). For example, a female student who is ethnically Vietnamese and born in the USA would have a different personal narrative than a recently immigrated male student who is ethnically Chinese but was born and raised until early adolescence in Cambodia. The female student may have good English language skills, but her family may rely on her to provide care for younger siblings, which could prevent her from excelling academically. The male student may be an excellent science student, but his limited English proficiency could prevent teachers from uncovering his expertise. Further, providing childcare to younger siblings is often not expected from a boy, less so in some cultures than others. By engaging in more meaningful interactions with students, parents, and community members (in this case, monks in the local temple and leaders from different ethnic civic organizations in the neighborhood), teachers and administrators at this school can begin to appreciate the experiences of individual students and their families that will enable them to better connect with their students as learners and to their experiences with school and science, which will provide them opportunities to understand individual, family, and community expectations for school, in general, and science learning, in particular.

Another example of categories that can be used is intracategorical complexity, where the teacher (researcher) focuses on groups that exist in the boundaries between categories and, as such, are often ignored. For example, using intracategorical complexity, a teacher begins with one category, such as gender, and then examines the similarities and differences within other categories, such as language proficiency level, race, ethnicity, immigration status, and science learning. From here, we may question, how are a student's science experiences ameliorated by the other categories? From this perspective, we would recognize that a student's prior science learning experience would be an important dimension that could contribute to his or her social location in the science class. One of the students in this vignette lived for several years in a refugee camp where he received no formal education, but he engaged in many different scientific investigations as his family was encouraged to grow their own vegetables for consumption. This required a lot of experimentation as the soil, seed, and weather conditions were unfamiliar to them at the camp. However, unless teachers engage their students to learn about their prior science learning (formal and informal) either in Cambodia, the refugee camp, or in other science classes once in the USA, then teachers cannot begin to draw on their students' knowledge of science.

So far in this chapter, we have highlighted some findings from macro level research that we find have limited potential to inform practice or policy at the meso (local) level, in communities and schools, or at the micro level, as interactions between teachers and students. We argue that only if researchers begin to make connections at the macro and meso levels between complex processes, like globalization and migration, can they begin to understand the micro interactions that occur between teachers and LM/ELL students in the science classroom. Because intersectionality asks that we acknowledge that an individual's social identity influences her or his beliefs about and experiences of gender, class, race, and ethnicity, we believe that by engaging intersectionality in the analysis of students' lives, researchers and teachers can begin to contest the social boundaries and categories that shape a student's opportunities for learning. If teachers are able to challenge the terms currently used to describe their students (e.g., immigrant, language minority, English language learner, female, male, Cambodian, or Chinese), they will be better positioned to question the implications of these labels for their students' experiences in school and science. For example, teachers could begin to consider what cultural practices could enhance and restrain their students' science learning and question how might those practices vary because of a student's gender, ethnicity, or native language. They might also consider how learning within science, a discipline focused on the observation of the natural world and the use of symbolic language, might help students obtain academic success in other subjects. Further, teachers might think about how a student's achievement in science could be impacted by native language proficiency or consider the degree to which the native language is utilized within the symbolic language used in science.

The examples we have shared in this section are meant to highlight the need for teachers to understand the sociohistorical context of the global forces impacting their students' e|im|migration experiences from their home country and to their new

country. We caution that teachers must also avoid generalized understandings about students' based on these intersections by acknowledging the fluidity represented in students' multifaceted, highly individual identities. However, until teachers begin paying attention to the intersections of these different categories, they will continue to be limited in their abilities to support students as individual science learners. In the following section, we consider additional implications for policy, research, and teacher education and even offer examples of transformative research being implemented by teacher researchers at the classroom level.

Implications

As a result of globalization, student populations in countries all around the world will continue to become more diverse. In order to better understand the issues and interactions between these students, their teachers, and school science, we need more powerful tools with which to analyze data that can tell us more about individual and social phenomena and in more complex ways. Using intersectionality as a framework provides researchers and teachers the opportunity to learn about the complex ways that instructional methods, modes of communication, and cultural practices in classrooms either support or constrain science learning for diverse students. If researchers are to generate findings that have important implications for policy, research, and teacher practice with regard to the growing LM/ELL student population in US K-12 schools, we believe they must employ new and different methodologies and theoretical frameworks so that they can better understand the complex relationship between globalization and e|im|migration at global levels and the resulting impacts on school environments at local levels. Fostering more meso and micro level research on LM/ELL students is warranted, especially studies that illustrate the complexities that exist within groups of students and that complicate the conclusions drawn by data gathered using broad labels such as "Asian" or "Latino/a."

Research that emphasizes the science learning needs of LM/ELL students and employs intersectionality has clear implications for research and teacher education. As such, we believe that intersectionality challenges researchers and teachers to conduct more nuanced analyses of the science experiences of marginalized students. This work underscores the tenets of social justice education and has the important long-range objective of providing opportunities for students from marginalized subgroups for future careers in STEM fields. In addition, this research can also inform preservice and in-service teacher education. A recent publication of *The Science Teacher* (2011) used the theme "*Science for all*" and included several articles on teaching science to ELL students. Those articles provide teachers with pragmatic advice on working with ELL students, such as knowing language proficiency levels of students and aligning content and language objectives (Bautista and Casteneda 2010). However, beyond just incorporating specific methods, it is critical that teachers have a keen, multifaceted understanding of their LM/ELL students' experiences, identities, and backgrounds.

Some courses and texts attempt to facilitate understanding about ELL students by providing overviews of different cultural groups, noting patterns in behaviors, beliefs, and other cultural aspects. These broader descriptions of patterns about students can be useful to teachers, school leaders, and policymakers, but we are hesitant to encourage reinforcing certain attributes or practices as "typical" because of the dangers of stereotyping subgroups. Rather, as teacher educators, we recommend that practitioners consider the intracategorical complexity in students' multifaceted identities. Teachers can develop their own understandings about individual students who belong to larger groups such as "girls," "ELL students," or "Puerto Rican female students in my science class" by engaging in action research on their teaching and student learning. Teachers can conduct interviews or surveys to gather information that allows them to develop a more nuanced, individualized perspective of their students. A growing number of urban science education researchers are supporting teachers and their K-12 students to implement cogenerative dialogues, a structured discourse method between students and teachers, that have been successful in transforming teachers and student practices in science (e.g., see Martin 2006; Martin and Scantlebury 2009). By engaging in cogenerative dialogues with students outside of class, teachers can expand opportunities for LM/ELL students to gain access to not only a new language but also improved understandings about the purpose of school and science. Additionally, through these dialogues, we believe teachers can gather information that will enable them to better differentiate and support their students' English and science learning while simultaneously offering opportunities for these students to become integrated into the learning community in more meaningful ways.

Finally, there are important implications for this research with regard to the development of policy that impacts research funding, curriculum, and assessment and mandates informing educational reform at local, state, national, and even international levels. So that educators can understand the impact of macro level processes like global and local migration and labor patterns at the classroom level, we need funders to support research that examines these issues at the national, state, and local levels. Drawing from this research, curriculum for teacher education programs could be developed that supports teachers to build and challenge their own understandings about what it means to teach science to linguistically and culturally diverse students in this era of globalization. For example, courses could be developed that enable teachers to appreciate the larger impact of globalization on education. We think this should be a critical component to teacher education programs in the future because the micro level understandings we advocate that teachers, administrators, and other school-based practitioners should have about students are directly impacted by the macro level processes of global and local migration patterns and labor patterns for immigrant families. Research examining the intersections of race, ethnicity, class, and gender on English language learners is needed if researchers and teachers, in the USA and in countries around the world, are to understand who students are as learners. We offer policymakers, educational researchers, teacher educators, and teacher practitioners two complementary frameworks, cultural sociology and intersectionality, as powerful tools for conducting research, which allow for more nuanced and complex understandings about issues facing science teachers and learners in an increasingly connected world.

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