Chapter 4
Opening STEM Careers to Hispanics

Abstract This chapter discusses Hispanics, the largest ethnic minority group underrepresented in the science and technology disciplines today. The first section describes the history of higher education for Hispanics in the United States. The middle section describes the history of science and technology education for Hispanics. The concluding section presents a history of Hispanic-Serving Institutions, one of the most important places for the higher education of Hispanic students.

This chapter discusses Hispanics, the largest ethnic minority group underrepresented in the STEM disciplines today.[1] The Hispanic population has been the fastest growing sector of the U.S. population for at least 30 years, growing 58 % in the decade of the 1990s and an additional 43 % from 2000 to 2010. As of 2010, there were 50 million Hispanics in the United States – 16 % of the population. (NCES 2011) In 2000, Hispanics surpassed African Americans as America's largest minority group.

Hispanics are a diverse group. The largest number of Hispanics in the United States have their origins in Mexico. However, a number have origins in Central and South America, the Spanish-speaking Caribbean islands, and Spain. Thus, rather than being a homogeneous group, Hispanics include people who speak various dialects of Spanish, have different racial and cultural heritages, have resided in the

[1] This book uses the term "Hispanic" when discussing this group of Americans. This is the term that is used by the US Office of Management and Budget (Directive Nol 15, May 12, 1977) in reference to "a person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race." Other terms can be used either for the entire group or to make distinctions within the group, as the following quotation from Marta, an academic administrator from California, indicates:

> My identity depends on who I'm talking to. It depends on which setting I'm in. If I'm writing, I call myself a Chicana. If I'm in a group of people who are in the community, who are the people who really are involved in community affairs like arts, those kinds of things, writers, literary people, *Chicana* is what I use so it's more politicized in those circles. At home and talking to other people I would say *Mexican American*, and with people who speak Spanish I would say *Mexicana*. Within the university, *Hispanic*, so these terms are used all the time. (as quoted in Ibarra 2001)

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United States for varying periods of time, are from different countries of national origin, and live in different regions of the country (e.g. those of Mexican origin live primarily west of the Mississippi River).

While there are only a few schools that were historically established explicitly to be Hispanic-Serving Institutions (unlike the Historically Black Colleges and Universities), with the population shifts a number of colleges have come primarily to serve Hispanics or are well along on the way to doing so (the so-called "Hispanic-emerging institutions"). The largest Hispanic populations are in the Southwestern states, the West Coast, Florida, and greater Metropolitan New York. This geographic distribution has a bearing on STEM careers because there is a strong Hispanic cultural value in caring for the extended family, which means that many Hispanic students are reluctant to move far from home to attend college or assume a professional job.

In 1973 and 1974, three organizations were formed to advance the opportunities for Hispanic scientists and engineers, the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), Latinos in Science and Engineering (MAES), and the Society of Hispanic Professional Engineers (SHPE). SACNAS is primarily oriented towards graduate education and research careers, whereas MAES and SHPE are primarily focused on professional degrees and engineering careers.

These organizations came into existence at a time when there were few Hispanics studying and working in the STEM disciplines. These developments followed closely on the civil rights movement, which began soon after the Second World War ended (e.g. the 1947 Supreme Court ruling in *Mendez v. Westminster* against racial segregation in California public schools; and in *Hernandez v.* Texas (1954), which provided equal protection under the 14th Amendment to the Constitution), but which heated up in the 1960s and early 1970s. Thus the creation of these STEM activities can be seen to be of a piece with better-known activities such as Cesar Chavez's organization of farm workers in the 1960s, the poor people's march on Washington, DC in 1967, the formation of the Mexican American Legal Defense and Educational Fund in 1968, and the formation of *La Raza Unida* political party for Mexican-American rights in 1970.

While Hispanics are still among the most underrepresented minority groups across the STEM disciplines, progress is being made. In 1979, of the 15,000 doctorates awarded in science and engineering disciplines, only 151 were awarded to Hispanics. Thirty years later, in 2009, the number of Hispanics receiving doctorates in the science and engineering fields had increased significantly – to 1131 – out of the 21,000 such doctorates awarded. While this is significant progress and represents a little more than 5% of the total, today the Hispanic population represents approximately 17% of the U.S. population; so Hispanics remain severely underrepresented in STEM doctorates.

4.1 Hispanics and Higher Education – A Brief History

At every stage, from elementary education through graduate school, there are significant challenges for Hispanic education in America.[2] Many Hispanics live in low-income communities, where the schools are underfunded. These schools often have a limited number of college-preparatory courses. Even where there are such courses, Hispanics are more often than Whites directed to vocational-track courses. There is often limited information available from counselors and others about the value in and process of going to college. Language and culture can both be an issue in gaining a good public education. High-school dropout rates are high (higher than for African Americans, for example), and many Hispanic students – especially males – drop out of school to get a job. College applications and admissions are low.

More than half of all Hispanic college students choose to attend 2-year community colleges over 4-year colleges. The community colleges typically cost less, are close to home, often provide open admissions that is attractive to students with poor high school preparation, and have night and weekend class schedules that are more convenient to the students who work large numbers of hours at the same time they are attending school.

Historically, community colleges have had the dual mission of providing lower-level vocational training as well as providing a pathway from high school to a 4-year college degree. However, many community colleges prioritize their vocational mission over their college preparation mission. In these colleges, there is often no transfer culture and inadequate counseling about the transfer process.[3] More than half of Hispanic community college students, even if their intention is a college-preparation

[2] The social science research literature about Hispanics and higher education is large. By far, the strongest literature is about 4-year college students. On the general background and characteristics of students, see especially Vélez-Ibáñez et al. (2013). Also see Darder and Torres (2014), HACU (1995), NCES (2011), Vernez (1997) and Vernez and Mizell (2001). On the history of policy efforts related to Hispanic education, see MacDonald (2004). On early formal education or K-12 education generally, see Leal and Meier (2011) and Moller et al. (2013a, b). On high school, including transition to college, see Brown et al. (1980), National Council of La Raza (1981), Duran (1983), Lopez (2013) and Boden (2011). On community college, see especially Saenz (2002). Also see Gross et al. (2014). On 4-year undergraduate education, see especially Solorzano et al. (2005), Oseguera et al. (2009), Arana et al. (2011), Kim et al. (2014) and Crisp et al. (2014). Also see Padilla and Montiel (1998), HACU (1994), Gonzales et al. (2014), Cavazos et al. (2010), Gross (2011), Montalvo (2012), Cano and Castillo (2010), Castellanos and Gloria (2007) and Valverde and Garcia (1982). On faculty and graduate school, see Delgado-Romero et al. (2007) and Ibarra (2001). These are the sources used to write this section.

[3] Ornelas (2002) highlights seven elements of successful conditions required for transfer: "(a) personnel at the college must be committed and must prioritize the transfer function; (b) institutions should provide programs with high expectations and accept responsibility for student transfer; (c) there should be an emphasis and availability of a transfer curriculum and articulation with 4-year colleges; (d) student progress to transfer must be continually monitored; (e) institutions should provide learning community programs so students can experience the transfer process in cohorts; (f) institutions should establish bridge and partnership summer programs with universities; and finally, (g) institutions must build on the assets and strengths of students, their families, and communities." (Also see Oseguera et al. 2009)

path, fail to transfer to a 4-year college. The most common reason is that they drop out to take a job. In fact, Hispanic students are much more likely to attain a college degree if they enroll in a 4-year college directly out of high school instead of taking the route through community college.

One successful program to address this issue of low rates of associate degree completion and transfer to 4-year colleges by Hispanics is the Puente program, a partnership between a network of California high schools and community colleges with the University of California system. The Puente program includes enhanced counseling, community mentors, and courses in Hispanic culture.[4]

Hispanic students are more likely not only to be paying for their own college education but also be contributing to family finances at the same time.[5] Thus it is not surprising that, for Hispanic students at community colleges, receiving financial aid of any sort is positively associated with degree completion – although social science research shows that this relationship attenuates over time. This caveat about attenuation is important because many Hispanic students take 3 or 4 years to complete their community college degrees, presumably because of work and family obligations. First-year community college students of Hispanic origin have been less likely to apply for grants than students from any other minority group. (Gross et al. 2014)

In addition to issues of adequate high school preparation and financial aid, Hispanic college students face other challenges to academic performance and persistence: "cultural and social isolation, negative stereotypes, low expectations from teachers and peers, and non-supportive educational environments." (Oseguera et al. 2009) Mentoring, financial aid, the ability to go to school full time, as well as community learning opportunities, have all been shown to enhance retention.

When Hispanic students do attend college, they find few Hispanic role models. Less than 5 % of faculty and college administrators are Hispanic. Even in Hispanic-Serving Institutions, only slightly more than half of the college presidents are Hispanic.[6] Hispanic students who come from homogeneous high schools experience more stress and alienation in college than those from heterogeneous high schools.

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[4] Oseguera et al. (2009) identify some other national programs that assist Hispanic college students at the community college or baccalaureate level: The Student Support Services program – part of the TRIO programs of the U.S. Department of Education – helps with basic study skills, counseling, mentoring, and assistance in completing admission and financial applications to 4-year colleges; ENLACE, a program of the Kellogg Foundation, helps communities to advance Hispanic students through public school and into college; and the Adelante U.S. Education Leadership Fund – a joint venture of Miller Brewing Company and HACU – provides counseling, academic support services, and other features on select college campuses.

[5] White families on average are wealthier than Hispanic families. According to the Urban Institute, in 2010 the average White family had family wealth (assets minus liabilities) of $632,000 compared to $110,000 for Hispanic families. (Miller and Horrigan 2014).

[6] Duran (1983) identifies the following factors as effective predictors of college achievement of Hispanic students: type of college (e.g. size, location, gender composition, general mission, etc.); general institutional commitment to the education of Hispanics; ethnic composition of the faculty and staff; peer support systems (counseling, tutoring, other services); institution-operated support systems (special orientation programs, advisory services, remedial and tutorial opportunities,

Before turning to STEM education for Hispanics and to Hispanic-Serving Institutions, we give a brief history of the politics of Hispanic education in the United States since the 1960s.[7] The 1960s are an appropriate time to begin this story because Hispanic educational protests and other political actions were part of the activism of the 1960s and 1970s that also included the Civil Rights, Black Power, Free Speech, Women's Rights, and American Indian self-determination movements.

There was cause for complaint. The public education for Hispanics was much worse than it was for Whites in the 1960s. On average, a Hispanic student had 3 to 4 fewer years of schooling than a White student. The schools teaching most of the Hispanic students were crowded and had weak infrastructures, and Hispanic students were commonly channeled into vocational tracks independent of their wishes and their academic capabilities. Instruction was delivered only in English.

A number of Hispanic activist organizations that were engaged in a wider set of issues participated in these education reform efforts. These organizations included the United Farm Worker's Association, the Mexican American Youth Organization, *La Raza Unida*, *Alianza de los Pueblos Libres*, and even the Young Lords street gang. The most visible of these protests were the walkouts that occurred in four schools in East Los Angeles in 1968, where a total of 15,000 students joined the protests. The walkouts spread to Texas and Colorado.

The fight over better public education for Hispanic students was also fought in the courts. One battle concerned separate but equal education. Although *Brown v. Board of Education* (1954) had overturned as unconstitutional the practice of separate but equal education for African Americans, separate but equal education persisted for Hispanics because many school districts treated Hispanics as Whites. With funding from the NAACP and the Ford Foundation, the Mexican American Legal Defense and Education Fund (MALDEF) fought on behalf of Hispanic students in the courts in the 1960s and 1970s. The landmark case was *Cisneros v. Corpus Christi Independent School District* (1970) in which the court ruled that Hispanics had to be treated as a separate minority group from Whites, and hence separate but equal education was illegal. After this ruling, MALDEF turned its attention primarily to bilingual education. However, the separate but equal issue was not fully resolved at this point, and there was still some wiggle room in the legal system for local school districts to persist in separate but equal education. Thus there continued to be battles over this issue in the state and local courts for some time after *Cisneros*.

A number of improvements in Hispanic education came in the mid-1960s through President Johnson's War on Poverty. The Elementary and Secondary Education Act (1965) included funding for migrant education, adult instruction in

extracurricular activities for Hispanic students); housing (academic attitudes of other residents); financial aid (amount, type, information about); and sponsorship of the student by some organization that takes a personal interest in the individual student's career.

[7] While a number of additional studies discuss the history of the federal designation of Hispanic-Serving Institutions, the account here is drawn primarily from MacDonald (2004), Galdeano et al. (2012) and Valdez (2013).

the English language, and early childhood education. The Bilingual Education Act (1967) provided substantial federal funds for Spanish-language instruction in the public schools. However, many local school districts resisted federal inducements to provide bilingual education. The federal government fought back through its Office of Civil Rights, requiring under Title VI regulations that any public school district receiving federal funds (hence all school districts) file compliance plans that explain how children whose native language is not English were not being unfairly treated. This issue was only finally resolved when the Supreme Court ruled in 1974 in *Lau v. Nichols* that the civil rights of children who did not speak English were being violated if the schools did not address their linguistic needs as part of public instruction.

At the same time that the protests were taking place in Los Angeles and Texas, Puerto Rican students and parents were protesting in New York City and Hartford, Connecticut. In 1968, PS 25 in New York City became the first bilingual public school in the Northeast. ASPIRA and the Puerto Rican Legal Defense Fund battled in the courts against the New York City Board of Education. A 1974 consent decree mandated bilingual education in the New York City public schools.

Also in the 1960s and 1970s, there were movements to address Hispanic higher education. The first Hispanic student organization, the Mexican American Youth Organization, was founded in 1967 at St. Mary's College in San Antonio, Texas; soon a chapter was opened at the University of Texas at Austin. In Los Angeles, not long thereafter, the United Mexican American Students organization opened chapters at both UCLA and Loyola University, and the Mexican American Student Organization was organized at East Los Angeles Community College. The first campus protest occurred in 1968, when five students walked off the stage and several hundred people protested outside the graduation ceremony at San Jose State University. An important conference held the following year at the University of California at Santa Barbara resulted in *El Plan de Santa Barbara*, which set out reform demands that were widely influential across the nation. *El Plan* called, among other things, for more open university access for Hispanic students and the hiring of additional Hispanic faculty and administrators.

At about the same time, Puerto Rican student activist organizations formed in New York City. There were major student protests in 1969 and 1970. These actions resulted in a change to an open admission policy in 1969 at City College, the academically strongest school in the CUNY system, thus leading to a flood of new African-American and Hispanic enrollments; the formation of a department of Puerto Rican studies at City College in 1971; and the creation of a new Hispanic institution of higher education, Boricua College, in 1973. Other developments included the opening of centers for Puerto Rican studies at various campuses of CUNY and SUNY, as well as at elite private universities such as Princeton and Yale, and at the University of Illinois-Chicago and Wayne State in Detroit.

There was little, if any federal funding targeted specifically at higher education for Hispanic students in the 1960s and 1970s. However, private foundations including Rockefeller, Carnegie, and Danforth made large investments.

The politics of Hispanic education in the 1980s and 1990s was closely associated with the large increase in Hispanic population in the United States during this time period. During the 1990s, for example, the Hispanic population grew by almost 60 %, largely through immigration. There was a serious backlash that led to majority protests to both affirmative action and welfare rights for immigrants. Texas and several other states tried to withhold funding to school districts that accepted undocumented students, but this practice was ruled unconstitutional by the Supreme Court in *Plyler v. Doe* (1982). Three times in the early 1980s, Congress introduced legislation to make English the official language of the United States, but each time the bill failed to become law. Frustrated at federal inaction, 23 states passed English-only laws in the 1980s or early 1990s; though eventually all of these laws were struck down by the courts. In the 1990s, California passed a series of restrictive propositions, including Proposition 187 (the Save Our State Initiative, which denied health care and public education to illegal aliens and which was also eventually struck down by the courts) and Proposition 227, which restricted bilingual education and promoted English-language use (and is still in effect).

The first major federal study of Hispanic education was published in 1980 under the title *The Condition of Education of Hispanic Americans*. (Brown et al. 1980) In response, the U.S. Department of Education increased support for national programs that were beneficial to Hispanic students, mostly at the K-12 level but also at the college level.[8]

Lobbying efforts in the 1970s by the League of United Latin American Citizens to increase Hispanic access to higher education were largely unsuccessful. The Hispanic Higher Education Coalition (HHEC), formed in 1978, was somewhat more successful and became a powerful political force throughout the 1980s.[9] HHEC's principal goal was to broaden Title III (the Strengthening Developing Institutions program) of the landmark Higher Education Act of 1965 so as to include support for Hispanic students. HHEC testified five times between 1979 and 1985 on reauthorization of the Higher Education Act; and in the 1985 reauthorization bill, legislation was introduced to include $10 million in Title III funds that higher educational institutions enrolling at least 20 % Hispanic students could apply for. This amendment was passed by the House but not by the Senate, so it did not become law.

As a result of the inability to get Congress to act on behalf of Hispanic higher education, a new organization (the Hispanic Association of College and Universities, known as HACU) was formed by academic and business leaders in 1986.[10] For the

[8] These included Title IV funding under the Higher Education Act of 1965, which includes student aid and the TRIO programs.

[9] The initial members of the Hispanic Higher Education Coalition were ASPIRA of America, *El Congreso Nacional de Asuntos Colegiales*, League of United Latin American Citizens, Mexican American Legal Defense and Education Fund, National Association for Equal Educational Opportunities, National Council of La Raza, Puerto Rican Legal Defense and Education Fund, the Secretariat for Hispanic Affairs, and the U.S. Catholic Conference.

[10] The impetus for forming HACU came from Dr. Antonio Rigual and Sister Anne Sueltenfuss of Our Lady of the Lake University in San Antonio, TX, who approached Xerox about funding to

1992 authorization of the Higher Education Act, HACU wrote language included in the bill that was passed by Congress providing funds to a new entity known as "Hispanic-Serving Institutions" (HSIs), which were defined as those having a Hispanic student population of at least 25 %. HSIs enrolling at least 50 low-income students were able to apply for Title III funding from a $45 million fund specifically set aside for HSIs.[11] While these funds were authorized in 1992, the first funds were not appropriated until 1995. In 1998, the funding for HSIs was moved to a new program under Title V of the Higher Education Act (the Developing Hispanic Serving Institutions Program), and the definition of an HSI was modified to require that the schools eligible for funding were accredited, degree granting, and nonprofit.

Another important political event in Hispanic education occurred when President Clinton, through Executive Order 12900, created a special committee to study Hispanic education with the task of addressing what federal, state, and local governments as well as private organizations could do to improve the situation. The Executive Order also called on each federal agency to examine its programs in support of education and identify ways to increase Hispanic participation in them. In 1996 the committee published its report, *A Nation on the Fault Line*. Increased funding was included in the Higher Education Acts of 1997 and 1998. The Clinton initiative also cleared the way for additional funding for a USDA HSI program under the reauthorization of the Farm Bill, as well as HSI funding through temporary funding programs from Housing and Urban Development and from the Department of Defense. The College Cost Reduction Act of 2008 provided $200 million for HSIs for articulation agreements and STEM education. The Student Aid and Financial Responsibility Act of 2010 extended the HSI programs from the College Cost Reduction Act for an additional 10 years. Nevertheless, federal funds provide only two-thirds as much funding per student to HSIs as they do to colleges and universities overall.

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establish a Center for Hispanic Higher Education at their school. They began meeting with representatives of Xerox and other HSIs, including Texas A&I Kingsville and New Mexico Highlands University. Eighteen colleges and universities were original members of HACU.

[11] Various percentages, from 20 to 40 %, were proposed over the years leading up to the 1992 law. The term "Hispanic colleges" had been used to designate these schools as early as 1979, but HSI has been uniformly used since 1992. The United College Negro Fund and some other organizations supporting federal support to African-American higher education, were resistant to expanding the Title III law to include other than Historically Black Colleges and Universities. Little known is that HHEC also lobbied for a larger allocation of the Title III funds for community colleges – a proposed increase from 24 to 40 % of the total funds – because of the large number of Hispanic students attending community colleges.

4.2 Hispanics and STEM Education – A Brief History

According to the U.S. Department of Education's Early Childhood Longitudinal Study, Hispanic children enter kindergarten with a significant educational achievement gap compared to Whites or Asians.[12] Preschool programs have been found to help to reduce that initial gap for Hispanic students and result in higher math scores by the age of 15. However, lower percentages of Hispanic children attend pre-school than any other major demographic group. Gandara (2006) cites the reasons given in the social science literature for this phenomenon:

> Latino parents maintain a strong sense of familism that runs counter to the practices of many preschool programs. In addition to simply retaining young children at home with family members for a longer period of time, many parents in their study remarked that teaching traditional values (such as respect for elders and authority figures) and use of the primary language were important concerns that they did not see supported in mainstream preschool programs. Parents may worry that their children will not be understood if caregivers and teachers do not speak Spanish, and they may also want to extend the familial language as long as possible before children enter the predominantly English-only world of school.

Many Hispanic students – perhaps as many as half in California – enter public school learning English as a second language. Those students tend to receive lower grades and be channeled into low-level and remedial courses as opposed to college preparatory courses. A few successful programs have been targeted at Hispanic students to encourage them to stay in school and prepare them for college.[13] One

[12] There is a great deal of overlap in the discussions in the social science literature about Hispanics and education generally and in the literature on Hispanics and STEM education. This section focuses on topics and results that are particular to STEM. On early public education and its effects on STEM trajectories for Hispanic students, see Gandara (2006). On high school and its effects on STEM career plans for Hispanic students, see especially Riegle-Crumb and Grodsky (2010) and Crisp and Nora (2012). Also see Zimmerman et al. (2011). On community colleges and Hispanic STEM education, see Gilroy (2012) and Malcom (2010). On Hispanic students and undergraduate degrees, see especially Camacho and Lord (2011). But also see Carpi et al. (2013), Crisp et al. (2009), Malcom (2008), Vasquez (2007), Cole and Espinoza (2008), Camacho and Lord (2013) and Fifolt and Searby (2010). Supplemental instruction is one of the common interventions employed in community colleges and baccalaureate programs in the STEM fields; on the impact of supplemental instruction programs on Hispanic students, see Rabitoy (2011), Meling (2012) and Meling et al. (2013). On STEM graduate education and Hispanics, see Millett and Nettles (2006) and Baker (2000). There is a large body of literature on the broad topic of STEM education and Hispanics, often also covering the more general issues of Hispanic education described in the previous section. See especially Rochin and Mello (2007), Taningco et al. (2008) and Miller and Horrigan (2014). Also see U.W. White House (2014), Landivar (2013), Anon. (2012), Flores (2011), Torres et al. (2014) and Chapa and De La Rosa (2006). On Hispanics and the STEM workforce, see Taningco (2008) and San Miguel et al. (2014). There is little general literature on Hispanics and computing education. See McFarland (2004) and Yau (2013).

[13] Successful programs include Achievement for Latinos Through Academic Success, which is targeted at middle schoolers; High School Puente and Achievement Via Individual Determination, which is targeted at high schoolers; and Project GRAD, which follows students from first grade through high school. (Gandara 2006)

notable program of this sort having a STEM orientation is the College Board's Equality 2000 program, which enhances high school math instruction as preparation for college STEM majors and STEM careers. The program has been a moderate success in low socioeconomic status and high-minority population schools.

Concern over the low U.S. scores in the International Math and Science Survey (TIMSS), plus a demand for a well-trained workforce from the technology sector in the 1990s, resulted in a call for enhanced math education in the public schools.[14] This has led to a significant increase in Hispanic students taking advanced math courses in high school,[15] but nevertheless significant achievement gaps continue to exist between Hispanic students and White students in those classes; and those gaps are the greatest in the highest level math courses: pre-calculus and calculus. Social scientists have identified some possible reasons for this phenomena: socioeconomically advantaged parents have greater knowledge of the higher educational system and can inform their children better and with more certainty; these parents tend to have higher educational and occupational expectations of their children; and these parents may also feel more confident in engaging the school and lobbying for their children's access to advanced courses. There are also institutional and other reasons: schools in wealthier communities have greater resources to devote, especially to "frills" such as advanced courses when they are being required to meet the No Child Left Behind standards; teachers, especially math teachers, of Hispanic students are likely to have fewer years of experience and be teaching outside of their field of expertise; and especially in these advanced courses, Hispanic students may fail to perform as well as they might on account of stereotype threat.[16] (Riegle-Crumb and Grodsky 2010)

Hispanic culture places faith in teachers as experts, and thus it is particularly effective when teachers direct Hispanic students towards STEM careers. Working-class and lower-class Hispanic parents are particularly deferential to teachers. One study suggests that teachers are particularly influential in the case of schools where there is a collaborative teaching environment (Moller et al. 2013b; also see Moller et al. 2013a).

Families can have a negative impact on Hispanic students attending college. Some of the reasons include parents holding gender-based stereotypes, being reluctant to take on the burden of loans for educational purposes, prioritizing spend-

[14] Elementary and middle school preparation in math and science has been shown to affect not only a student's academic preparation for high school STEM courses, but also student interest in taking such courses and in pursuing a STEM major in college. For a review of this literature, see Crisp and Nora (2012).

[15] 3 % of Hispanic high school graduates from the Class of 1982 had completed a pre-calculus course, compared to 15 % in 2004.

[16] Another study (Crisp and Nora 2012) points to literature that Hispanic students have lower feelings of self-efficacy than Whites in math and science, and that this type of self-efficacy is a strong predictor of a choice of a college STEM major. This same paper cites literature on gender and its impact on Hispanic choice of a STEM major, arguing: "as early as junior high school, at which time Latina students may be more hesitant to ask questions during class discussions, less likely to report that they are looking forward to taking eighth grade mathematics classes, and are the least likely of any group to have STEM career aspirations".

ing on other expenses than education, and pressuring their children to take jobs as soon as they graduate from high school. (Taningco 2008)

There has been little study of Hispanic high school students and their interest in computer science.[17] One study (Zimmerman et al. 2011) compares to other nearby schools a charter school in East San Jose, CA with a curriculum designed to encourage Hispanic students to attend college and increase their proficiency in English. The computer science study found that the Hispanic students were especially influenced by job compensation (they generally come from low-income families); knowing someone in the computing field; and gaining programming, robotics, or electronics experience through exposure to computers. The study also found what many other studies say about girls: Hispanic girls were interested in how computing applies to other fields.

Gilroy (2012) points out the advantages of community college for Hispanic students interested in STEM careers. Class sizes are small, so there is more chance for the student to interact with professors, obtain hands-on laboratory experience, and gain access to tutoring centers – all benefits that may be in short supply at a large public university. These advantages are regarded as a way of helping Hispanic students to persist in the face of what many students regard as challenging courses. Community colleges often enroll a diverse student population, which may be more comfortable for Hispanic students. Many community colleges are responsive to the needs of local employers, so many of the STEM students may find the curriculum more relevant to the outside world.

Social science research has found that, in both community colleges and 4-year colleges, supplemental instruction has been an effective means for improving academic performance and retention, particularly among Hispanic STEM students. Supplemental instruction was pioneered at the University of Missouri at Kansas City in the early 1980s and has been adopted by more than 800 colleges. It is typically used in connection with gateway courses in math and science – for example, college algebra, or introductory college-level physics and inorganic chemistry. These are courses that the students find difficult and for which there is high incidence of low or failing grades. Under this initiative, students meet outside of class in small study groups with a supplemental instruction leader to review basic material from the course and hone their study skills. It is a cooperative, participatory environment in which the students set the agenda of material to be covered and are responsible for helping each other to learn. In a study of a Hispanic-Serving Institution in Texas, participation in supplemental instruction for these gateway math and science course – no matter whether the student's level of participation was slight or great – led to increased course completion and higher course grades for Hispanic undergraduates. (Meling 2012)

[17] There are similarly few studies of Hispanic students in college degree programs in computing disciplines. See, for example, McFarland (2004) on the management information science and computer science curriculum at Western New Mexico University. Also see the discussion of the computing programs at the University of Texas at El Paso and some of its partner institutions in the NSF Broadening Participation in Computing Alliance known as CAHSI, as discussed in Aspray (2016).

Both male and female Hispanic students persist in their college education in engineering at a similar rate to Whites overall (slightly over half are still enrolled by the time of their eighth semester). However, unlike fields such as business, a lower percentage of Hispanics are recruited into engineering majors and careers than Whites. Thus the problem for Hispanic students in the STEM disciplines is one of recruitment rather than retention. This occurs despite the fact that engineering is the most intended major among male Hispanic high school students planning on entering a STEM discipline (and the third most common, behind social and behavioral sciences, and biological and agricultural sciences, for Hispanic females). Since the 1990s, the numbers but not the percentages of Hispanics graduating with engineering degrees have increased.

One of the challenges for Hispanic undergraduate engineering majors is a feeling of isolation. The professional societies MAES and SHPE (both described in Chap. 7) have worked on building community among Hispanic engineers and engineering students. Because of the heavy demands of science and engineering degrees, it often takes students longer to complete these majors. As a result, an issue of particular concern is financial aid. Another research finding is that minority student interest in STEM is correlated to the percentage of minority students at the college who are STEM majors. This may be one reason that more than half of the Hispanic students earning STEM degrees attend Hispanic-Serving Institutions, and that the HSIs are the fastest growing producer of STEM degrees for Hispanics. Another reason may be that the HSIs are less likely to teach their introductory science and math courses in large, impersonal lecture classes – as is often the case in large majority institutions. HSIs are also more likely to offer more culturally sensitive programming. Another possible reason is that the HSIs have more role models for students, and the social science literature shows a correlation between the presence of role models and student self-efficacy in their STEM major.

One issue faced by Hispanic students attending a majority institution is finding a mentor who is from the same cultural background. Fifolt and Searby (2010) explain some of the issues:

> Faculty and other professionals need to be prepared for potential issues that can arise as a result of cross-cultural mentoring relationships. They may see that students possess cultural mistrust … based on personal history and experiences of racism or mistreatment by the majority race or a reluctance to establish a relationship with the cross-cultural mentor for fear of having the appearance of betraying one's own cultural group. Mentors may find students who feel inhibited based on hierarchical power structures, both real and perceived, and who are less willing to participate fully in the mentoring relationship based on concerns of cultural stereotyping by the mentor. Finally, the mentor may also possess cultural mistrust, negative cultural biases, and fears about being successful in relating to someone from another culture based on a negative experience or a lack of experience with a culture that is different from his or her own.

There are only a few studies of Hispanic graduate students in the STEM fields. Based on data that is now 15 years old, Hispanics have a lower completion rate than Whites in doctoral studies in engineering. This is despite the fact that Hispanic and White doctoral students in the STEM disciplines were equally likely to hold a teaching or research assistantship or to have a mentor. (Millett and Nettles 2006) Using

data from 1983 to 1997, another study (Baker 2000) showed that in the STEM disciplines, White and Hispanic doctoral students had similar distributions in their area of study, with the biological sciences highest, the physical sciences next highest, and engineering lowest of all. The Hispanic students were much more likely than the White students to have mothers and fathers who had received only a high school education or less. Most of the Hispanic students earned their doctorates at public universities with Research I Carnegie classifications, and most of those students studied in regions of the country in which there were large Hispanic populations.

Many Hispanic doctoral students have received their undergraduate education in Texas, New Mexico, California, Florida, or Puerto Rico. Hispanic-Serving Institutions have been among the top producers of baccalaureates for Hispanic students who went on to study for their doctoral degree. For doctoral completion, a study by Baker (2000) identified the most commonly mentioned factors: "a caring faculty, a supportive environment facilitated by the use of strong intervention strategies, good advising and counseling services, mentoring, peer tutoring, and the availability of role models in the community."

The number of doctoral degrees awarded to Hispanics in all fields produced annually in the United States remained low from 1976 to 1994: fewer than 1000 in each of those years and typically representing no more than 2 % of all doctorates awarded. However, doctoral degrees earned by Hispanic students began to pick up after 1994, and in 2004 there were more than 1600 Hispanic recipients of doctoral degrees. From 1976 through 1998, Hispanic males received more doctorates than Hispanic females, but from that year forward, more Hispanic women than men were earning doctorates, and the gap is widening each year.

4.3 Hispanic-Serving Institutions – A Brief History

Hispanic-Serving Institutions[18] differ from HBCUs or tribal colleges in that the HSIs – in all but a few cases[19] – did not have a historic mission to serve Hispanic students and many of them do not have an identity centered on serving these stu-

[18] The general literature on HSIs consulted here includes U.S. House of Representatives (2003), Stearns et al. (2002), Murphy (2013) and Laden (2001, 2004). Literature focused on administrative and institutional issues – usually for 4-year HSIs but sometimes for all HSIs – includes Garcia (2012), Espinoza and Espinoza (2012), Lu et al. (2014), Godoy (2010), Mulnix et al. (2002), De Los Santos and Cuamea (2010, 2008), Torres and Zerquera (2012) and Santiago (2012). Literature taking a student-centered approach (attraction of an HSI, sense of belonging, persistence, etc.) include Musoba and Krichevskiy (2014), Butler (2010), Núñez and Bowers (2011), Cuellar (2014) and Crisp and Cruz (2010). Literature focused specifically on HSI community colleges includes Núñez et al. (2011), Perrakis and Hagedorn (2010) and Gastic and Nieto (2010). Rudolph et al. (2014) focuses on graduate school and Ginther et al. (2011) discusses biases in research funding.

[19] The only universities, other than those in Puerto Rico, with a historical mission to serve Hispanics are: National Hispanic University (California), St Augustine's College (Illinois), Boricua College (New York), Northern New Mexico University, and Hostos Community College (New York).

dents. There is a wide variation across HSIs as to whether they provide specific services to address the needs of Hispanic students, and whether the school identifies itself as an HSI.

Although the number of HSIs nationally changes each year with fluctuations in enrollments, the numbers have been steadily climbing as the Hispanic population increases, and as the numbers of Hispanic students attending community and 4-year colleges also increases. The numbers have grown rapidly because of the Civil Rights movement, increasing availability of financial aid for college, waves of immigration from Latin America since 1980, and relocation around the country in search of employment. The number of HSIs has grown from 242 in 2003 to 370 in 2013; and there are an additional 277 "emerging" HSIs, in which Hispanics make up between 15 and 24 % of the student population. 59 % of Hispanic undergraduates attend HSIs. 52 % of HSIs are 2-year colleges. 38 % offer some kind of graduate degree. 18 % offer a doctorate. The typical HSI has fewer than 2000 Hispanic students enrolled. 61 % of the HSIs have open admissions policies (compared to 38 % of all US higher education institutions). Although the largest concentrations of HSIs still are found in Florida, New York, and the states bordering Mexico, HSIs are increasingly appearing in many rural and urban areas widely scattered across the United States. (Dervarics 2014)

HSIs are dependent to a large degree on state and federal funding for their operations, and as a result they have limited funds to spend on institutional advancement activities such as fundraising, public relations, alumni affairs, marketing, enrollment management, and government relations. Using data from 1998, which nevertheless appears to still be at least somewhat representative of today's situation, total revues of HSIs are 42 % less per full time equivalent student than an other universities; endowment funds at HSIs are 91 % less than at other institutions; and HSIs spend 43 % less on instruction, 51 % less on academic support functions, and 27 % less on student services per FTE student than other higher educational institutions. (Mulnix et al. 2002)

More than half of HSIs are community colleges. Common attributes of a Hispanic student in an HSI community college include being male, first generation to attend college, working, responsible for a family, attending school part-time, older, and never having attained a high school diploma. These characteristics present risks of not completing college. Hispanics make up about half of the students enrolled in the typical 2-year HSI, but these schools also enroll significant numbers of other minorities. In some cases, the students enroll not because they are aware that the school is Hispanic-Serving but instead because it is located near home or work, allows part-time enrollment, offers classes at times convenient to work schedules, or because the costs are low. Hispanic students in the 2-year HSIs are less likely to graduate with an associate's degree or a certificate than students overall.

Not only are Hispanic students often unaware that they are attending an HSI, some of the emerging HSIs themselves are also not paying close attention to the fact that their Hispanic enrollments are growing to a point that they are approaching or have actually attained the status of HSI. In a content analysis of the websites of 19 HSIs, 8 of these schools appeared to be unaware of their HSI status, 6 were aware but not building programs specifically for their Hispanic students, and 5 appeared

committed to building programs that served the Hispanic community.[20] (Torres and Zerquera 2012)

There is a significant body of social science literature concerned with the administration and institutional characteristics of HSIs. For example, in a survey administered in 2007, HSI presidents and chancellors identified (in order) their five greatest challenges: lack of funding, poor academic preparedness of students, low student retention and completion rates, hiring a diverse faculty that was adequately prepared, and keeping college tuition affordable. (De Los Santos and Cuamea 2010) Institutional resources as well as selectivity of the institution have been correlated in multiple studies to graduation rates for Hispanic students. (See Garcia 2012)

The costs of operating an HSI are generally higher than those for operating a predominantly White school because of the perceived need to provide the many nontraditional Hispanic students with mentoring, tutoring services, career counseling, exposure to cultural events, supplemental instruction learning assistance centers, and information literacy instruction at higher rates than is deemed necessary for White students. The challenges are great for these HSIs because the majority of them are public institutions where there are calls from legislators for efficiency in the delivery of instruction (measured as decreases in state support per student), while at the same time typically having to manage rapid growth in student numbers. There are increasing calls from politicians to measure the effectiveness of these schools (often in terms of graduation rates), but it is hard to determine appropriate metrics for evaluating the education of these nontraditional students. The provision of adequate services to educate and graduate non-traditional students is often in conflict with efforts to build up a school's institutional prestige – it is often a competition between excellence and access.

There is also a substantial body of social science literature on the experiences of students at HSIs. One of the topics covered thoroughly in the literature is persistence. (See Musoba and Krichevskiy 2014; Musoba et al. 2013; Maestas et al. 2007; Cuellar 2014) What factors relate to the persistence through an undergraduate degree for students at an HSI? Elevated high-school grades (but not elevated SAT scores), elevated grades in the first math and first English courses in college (but not elevated first-semester GPA), academic integration, developing a higher sense of academic self-concept over the course of college,[21] having a sense of belonging,

[20] The content analysis of the institutional websites focused on eight characteristics in determining the institutional readiness to be an HSI:

- Institutional mission;
- Emphasis on local community;
- Approach to diversity issues;
- Institutional plans posted on web site;
- Marketing strategies for enrollment;
- Student support program, especially for students of color and Latinos;
- Stated approach to serving the local community; and
- Any additional mention of Latino/a in the web site. (exact quotation, Torres and Zerquera 2012).

[21] Factors that were found to be positively correlated to gaining a better academic self-confidence include engaging in tutoring, interacting outside of class with faculty, doing homework, and having conversations with peers about their studies. (Cuellar 2014)

higher family income, and the receipt of financial aid all correlate to persistence through the degree.

One issue that has been studied is why Hispanic students so often attend HSIs. One theory (Braddock's perpetuation hypothesis) argues that racial segregation is perpetuated across institutional settings. This theory would indicate that Hispanic students who attended principally Hispanic high schools might select HSIs. However, another study (Butler 2010) showed that proximity of the nearest 2- or 4-year college explained most of the selection phenomena of an HSI and that it was not about perpetuation of racial segregation. The average distance in first college choice for a Hispanic student coming from a predominantly Hispanic high school is 84 miles (compared to 196 miles for African-American students from predominantly Black high schools).

Many Hispanic students come from lower socioeconomic backgrounds. One study (Núñez and Bowers 2011) found that a lower socioeconomic background is correlated both with attending an HSI instead of a predominantly White institution and with selecting a 2-year HSI over a 4-year HSI. Hispanic students who come to college from a high school with a high student-to-faculty or high student-to-counselor ratio are more likely to select a 2-year HSI. Núñez and Bowers speculate this is because high schools with these characteristics are "less likely to offer access to a curriculum that is 'constrained' to college preparatory classes." Interestingly, 4-year HSIs are more likely to enroll student bodies that are less well prepared in mathematics; nevertheless, these 4-year HSIs award high numbers of STEM degrees. This suggests to Núñez and Bowers that "high-performing HSIs successfully cultivate 'talent development' among students with varied academic preparation."

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