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With the majority of Latinos attending community colleges, it is important to understand ways in which these institutions contribute to the production of Latina/o STEM degree holders. This chapter discusses implications from a study of institutional pathways traversed by Latina/o STEM baccalaureates.

Charting the Pathways to STEM for Latina/o Students: The Role of Community Colleges

Lindsey E. Malcom

Three numbers encapsulate the purpose of this chapter: two million, 4.3 percent, and one-half. *Two million* refers to the number of new professionals needed to enter science, technology, engineering, and mathematics-related (STEM) fields by 2010 just to replace baby boomers retiring from the STEM workforce (IBM Corporation, 2008). The second number, *4.3 percent*, represents Latinos' current share of the U.S. STEM workforce (National Science Foundation, 2007). And *one-half* refers to the current proportion of school-aged youth who are Latina/o (U.S. Census Bureau, 2008). Why should we take notice of these numbers? The first indicates the pressing need for more highly trained U.S. scientists, engineers, and technicians, while the second is illustrative of the ongoing underrepresentation of Latinos in high-demand STEM fields. The third number represents an opportunity to enlarge the STEM talent pool and points to a necessary course of action to strengthen the U.S. competitive condition in an increasingly knowledge-based economy.

Latinos represent the nation's fastest-growing demographic group, and the U.S. Census Bureau (2008) projects them to comprise nearly 30

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percent of the U.S. population by 2040. Given this demographic trend, dramatic increases in the proportion of Latinos earning STEM bachelor's and graduate degrees and entering the STEM workforce are necessary for the future economic health of our nation.

The underrepresentation of Latinos (as well as African Americans and Native Americans) in the sciences is not a new problem. There have been longstanding calls to increase participation among students of color in higher education in general, and in the STEM fields in particular. Indeed, the number of Latinos and other underrepresented minorities enrolling in some form of postsecondary education and earning bachelor's and graduate degrees exceeds previous levels (National Center for Education Statistics, 2007). However, the share of Latina/o STEM degree holders and Latina/o STEM professionals remains disproportionately low (NSF, 2007). Numerous reports, statistical briefs, and papers by educational researchers and policy experts explore this problem and attempt to identify barriers to STEM access and success for Latinos and other underrepresented minorities. Yet until recently, the role of community colleges in serving as an entry point and pathway to STEM degree attainment has been largely absent from the discourse (Brazziel and Brazziel, 1994, is a notable exception), despite the pivotal role of these institutions in providing college access. Latinos are more likely to attend community college than are individuals from other racial/ethnic groups (Adelman, 2005), and nearly 60 percent of all Latinos enrolled in postsecondary education attend a community college (National Center for Education Statistics, 2005).

This chapter provides a partial picture of the ways in which community colleges have served as an institutional pathway for Latina/o STEM bachelor's degree holders. I describe key differences in patterns of access of Latina/o STEM baccalaureates by pathway and discuss the ways in which already narrow pathways to advantaging four-year institutional contexts contract even further for Latina/o STEM majors who attend community college. The absence of appropriate data at a national level limits researchers' ability to fully characterize the institutional pathways to STEM for Latinos and inhibits our understanding of ways in which traversing a particular path structures opportunity for underrepresented students in STEM fields. Nevertheless, the results of this study of Latina/o STEM baccalaureates offer insights into their pathways to STEM and raise important questions that ought to be addressed by future research. I conclude by discussing these implications for further research at the institutional level.

Study Description

Previous research underscores the importance of considering the interactions between the environments in which Latinos are located and their

decision making regarding postsecondary enrollment, college financing, major selection, and graduate school attendance (Admon, 2006; Padilla, 2007; Perna, 2006). We have limited information about how community colleges and Hispanic-serving institutions (HSIs) serve as institutional pathways for Latina/o STEM majors, despite their central role in educating Latinos. Furthermore, existing studies on Latinos in STEM often fail to make linkages between the economic and financial aid policy contexts that shape these students' decisions related to pathway selection and college enrollment. Instead, these two strands of research are separate in the literature, and questions of college financing strategies, borrowing, and the relationship between indebtedness and graduate education rarely intersect with studies of access and success for Latinos in STEM.

The findings presented in this chapter originate from a larger study of the institutional and financial aid pathways of Latina/o STEM baccalaureate degrees (see Malcom, 2008; Malcom and Dowd, 2008) that sought to fill in this gap in the literature. This exploration of the institutional and financial aid pathways traversed by those Latinos who successfully earned a bachelor's degree in a STEM field broadened our understanding of the problem of the underrepresentation of Latinos in STEM fields by focusing on the ways in which key contextual variables shape Latina/o STEM bachelor's degree holders' patterns of participation. Specifically, I analyzed the National Science Foundation's 2003 National Survey of Recent College Graduates (NSRCG) to address three research questions:

1. What are the postsecondary institutional pathways that Latina/o STEM bachelor's degree holders follow?
2. What college financing strategies do Latina/o STEM baccalaureates employ?
3. What is the effect of indebtedness on enrollment in graduate school among Latina/o STEM baccalaureates?

The analytical strategies for addressing the three research questions consisted of descriptive statistical techniques, latent class analysis, and propensity score matching, respectively.

The National Science Foundation defines STEM fields as computer science, mathematics, life sciences, physical sciences, behavioral and social sciences, and health-related fields. The 2003 NSRCG provides information on a nationally representative sample of individuals who earned a STEM bachelor's or master's degree (or both) from a U.S. institution between the academic years 2000 to 2001 or 2001 to 2002. The analytical sample consisted of Latinos who earned a bachelor's degree in computer science, mathematics, life science, physical science, behavioral science, engineering, or a health-related field (social sciences are excluded from the analysis) from a mainland U.S. institution during the two academic years. To characterize the role of community colleges in producing

Latina/o STEM bachelor's degree holders, I used descriptive statistical techniques, accounting for the complex survey design of the NSRCG.

For the purposes of the analyses, I narrowly defined community college students as those who attended community college and earned an associate degree. This approach was necessitated by the fact that the variable in the NSRCG indicating community college attendance does not indicate the number of units earned or the dates of attendance. Certainly this approach excluded some students who used the community college as a pathway to a STEM bachelor's degree by transfer, as many students do not earn an associate degree before transferring. However, it also allowed the identification of community college students and transfers with greater certainty. The findings presented here therefore reflect the population of transfer students who earned associate degrees.

Although this represents a limitation in that the population under study is a subset of all community college transfer students, the current higher education policy environment in which heavily incentivized or mandated associate degree attainment is being explored as a means to increase the efficiency of public higher education systems makes this population particularly interesting. As state policymakers consider making the associate degree a necessary step for more students, it is important to understand the extent to which associate degree holders gain access to STEM bachelor's degrees and the ways in which these students might differ from non-associate degree holders in terms of educational outcomes (for example, baccalaureate-granting institutional characteristics, field of study, and patterns of participation in financial aid).

The larger study of institutional and financial aid pathways focused on end points in the sense that it was backward looking, examining the experiences of those Latinos who successfully earned a STEM degree. Although the data and methods that I employed did not allow me to delve into the everyday moments that lead to student success, studying end points and understanding the interactions between context and the educational progression of Latina/o STEM degree holders provided markers for further inquiry at the national, state, and institutional levels. In the next section of this chapter, I discuss key findings regarding the pathways of Latina/o STEM baccalaureates.

Summary of Key Findings

Sixty-one percent of Latina/o STEM bachelor's degree holders attended community college at some point in their educational careers, and slightly more than 18 percent earned an associate degree from a community college prior to attaining the bachelor's degree. Latinos who were older and first-generation college students primarily used this unconventional pathway to the STEM bachelor's degree (see Table 3.1). Sixty-four percent of Latina/o STEM bachelor's degree holders who earned an associate degree

were nontraditionally aged (twenty-five years or older at the time of the awarding of the baccalaureate). The overrepresentation of older students among associate degree holders is quite striking considering just 32 percent of all Latina/o STEM baccalaureates were nontraditional students. This finding mirrors the patterns observed regarding all Latina/o students, wherein nontraditionally aged students are more likely to attend community college.

Parental education was also an important contextual factor associated with Latina/o STEM bachelor’s degree holders’ institutional pathways. Nearly three-quarters of Latina/o STEM B.S. holders who earned an associate degree had parents who had not earned a bachelor’s degree, compared to 60 percent of non–associate degree holders. This indicates that students whose parents were less familiar with postsecondary education more commonly used the community college as a pathway to the STEM baccalaureate than those whose parents had earned at least a bachelor’s degree. Although parental education levels are not a perfect proxy variable, they are commonly associated with socioeconomic status and access to various types of capital (for example, economic, social, and cultural).

Table 3.1. Demographic Characteristics of Latina/o STEM Bachelor’s Degree Holders by Associate Degree Status

		<i>Institutional Pathway</i>		
		<i>A.A. or A.S. from Community College</i>	<i>No A.A. or A.S. from Community College</i>	<i>Total Latina/o</i>
Nontraditional student status	Nontraditionally aged student	64.1%	24.6%	31.7%
	Traditionally aged student	35.9	75.4	68.3
Highest parental education level	Less than high school	22.2	11.9	13.8
	High school diploma or equivalent	13.4	23.0	21.3
	Some college, vocational, or trade school	37.5	24.7	27.0
	Bachelor’s degree	13.5	18.7	17.8
	Graduate degree	13.4	21.6	20.2

Notes: Column proportions. All differences are statistically significant. May not sum to 100 percent due to rounding.

Source: Analyses of the NSF 2003 *National Survey of Recent College Graduates* (NSRCG), using final survey weight.

The demographic characteristics of Latina/o STEM baccalaureates, who earned an associate degree, suggest that the utilization of community college pathways tends to be more prevalent among disadvantaged students. Previous research on educational opportunity indicates that accumulated disadvantage acts to limit ways in which Latinos access college, resulting in the highly stratified enrollment patterns of these students. Findings from my study suggest these patterns also apply to Latinos who earn degrees in science and related fields. While relatively high proportions of all Latina/o STEM bachelor's degree holders are nontraditionally aged and first-generation college students, those who earn associate degrees at a community college prior to attending a four-year institution are more likely to possess these characteristics.

Compounding the initial disadvantages that Latina/o students who attend community colleges possess, previous research tells us that community college attendance further disadvantages students in terms of a variety of educational outcomes (Adelman, 2005), although there is some debate as to whether this applies to Latina/o students (Melguizo, 2009). From a sociocultural theoretical perspective, one could argue that because many perceive community colleges to be lower-status institutions, community college attendance limits the acquisition of various forms of capital, thereby furthering the accumulation of disadvantage. To understand if Latina/o STEM bachelor's degree holders who traversed community college pathways and earned an associate degree might experience further disadvantages, I examined differences in the STEM baccalaureate-granting institutional characteristics of associate degree earners and non-associate degree earners.

Analyses revealed that Latina/o STEM bachelor's degree holders who earned an associate degree also tended to earn the B.S. from less selective, public, nonresearch institutions. Among associate degree holders, pathways to highly selective, private institutions and research universities were particularly narrow compared to Latina/o STEM baccalaureates who did not earn an associate degree (see Table 3.2). Less than 7 percent of associate degree earners graduated from institutions classified as highly selective (designated on the academic competitiveness scale as highly competitive, highly competitive plus, or most competitive in the 2004 *Barron's Profiles of American Colleges*), compared to nearly 31 percent of non-associate degree earners. Nineteen percent of associate degree earners attended private four-year institutions, while 34 percent of non-associate degree earners did. In addition, just below 18 percent of Latina/o STEM bachelor's degree holders who earned an associate degree graduated from research universities, compared to nearly 40 percent of non-associate degree earners.

The disparities in representation among Latina/o STEM graduates from highly selective institutions and research universities experienced by associate degree earners are problematic. Although these students have

Table 3.2. Baccalaureate-Granting Institutional Characteristics of Latina/o STEM Bachelor's Degree Holders, by Associate Degree Status

		<i>Institutional Pathway</i>		
		<i>A.A. or A.S. from Community College</i>	<i>No A.A. or A.S. from Community College</i>	<i>Total Latina/o</i>
Control	Public	80.7%	66.1%	68.7%
	Private	19.3	33.9	31.3
Carnegie classification	Research University	17.7	40.1	36.0
	Doctoral University	19.1	14.7	15.5
	Master's College/ University	47.5	32.3	35.1
	Liberal Arts College	8.8	12.7	12.0
	Specialized Institution	6.9	0.2	1.4
Selectivity	Nonselective	27.8	20.1	21.5
	Selective	32.9	27.4	28.4
	Very selective	32.8	21.9	23.9
	Highly selective	6.5	30.6	26.3

Notes: Column proportions. All differences are statistically significant. May not sum to 100 due to rounding.

Source: Analyses of the NSF 2003 *National Survey of Recent College Graduates* (NSRCG), using final survey weight.

successfully attained a bachelor's degree in a STEM field, the classification of baccalaureate-granting institutions matters in terms of the resources and opportunities afforded to students within institutional environments and the resulting postbaccalaureate outcomes. Multiple studies (for example, Brewer, Eide, and Ehrenberg, 1999; Dale and Kruger, 2002; Eide, Brewer, and Ehrenberg, 1998; Monks, 2000) reveal the numerous educational and economic benefits conferred on low-income and minority students who attend selective institutions, including increased chances of enrolling in graduate school and higher earning potential.

Furthermore, attendance at highly selective research universities is associated with increased opportunity to engage in scholarly research as an undergraduate, which increases retention, faculty interaction, and graduate school aspirations among underrepresented students in the sciences (Foertsch, Alexander, and Penberthy, 1997; Kardash, 2000; Kinkead, 2003; Sabatini, 1997; Seymour, Hunter, Laursen, and DeAntoni, 2004). Yet because Latina/o STEM baccalaureates who earned an associate degree graduate from highly selective institutions and research universities in significantly smaller proportions than non-A.A./A.S. degree earners, they likely do not reap the multiple benefits associated with attending these institutions.

It is important to remember that these findings apply to Latina/o STEM baccalaureates who earned an associate degree and do not necessarily reflect the experiences of all STEM bachelor's degree holders who transferred from a community college. However, 34 percent of Latina/o STEM bachelor's degree holders who never attended a community college graduated from highly selective institutions, compared to just 21 percent of those who did attend a community college at some point in their educational careers. Although this is far from a definitive conclusion about the institutional pathways traversed by all Latina/o STEM degree holders who transferred from community college, the findings certainly suggest that transfer access to selective institutions is an area of concern for Latina/o STEM majors.

New Directions for Future Research

The narrow pathway from community college to certain four-year institutional contexts for Latina/o students in STEM fields is troubling. Findings from my research mirror patterns of access characterized in previous empirical studies of community college transfer students (Dowd, Cheslock, and Melguizo, 2008; Melguizo, 2009). Limitations in the data and methods employed in the study examined here, however, allowed only a partial understanding of the institutional pathways that Latina/o STEM majors traverse. Furthermore, this study did not delve into the origin of what appear to be disturbing patterns of stratification in access (and perhaps outcomes) for Latina/o STEM majors who attend community college. Additional research at the national, state, and institutional levels using a variety of data sources and methods will allow us to gain a better grasp on the academic experiences of Latina/o STEM majors who attend community college and strengthen our understanding of barriers these students face. Below, I discuss specific areas for inquiry at the institutional level.

Modeling Community College Pathways to STEM. This study revealed that while slightly less than one-fifth of Latina/o STEM baccalaureates earned an associate degree at a community college, nearly 61 percent attended community college at some point in their educational careers. Do these students simply transfer from the community college without earning the associate degree? Or do they take courses for credit by reverse transfer or “swirling” (that is, concurrent enrollment at two-year and four-year institutions; McCormick, 2003)? These two functions are very different, and knowledge of the roles that community colleges play in educating students of color in STEM is necessary for better understanding the ways in which these institutions contribute to efforts to diversify the STEM talent pool. National data sets that do include the detailed transcript-level information required to address these questions typically do not include sufficient numbers of minority STEM majors to conduct robust analyses. Yet it is important to characterize the community college

experiences of all STEM degree holders, particularly underrepresented minority and low-income students.

Currently, researchers can more easily conduct the detailed transcript analyses required to model the pathways of minority STEM majors at the institutional level. Identifying curricular points of entry and exit for these students is particularly critical to our understanding of the function of community colleges in educating Latina/o STEM bachelor's degree holders. Furthermore, this type of analysis will enable researchers to identify course-taking patterns among community college attendees and determine the extent to which these patterns change over various dimensions (for example, time and academic field). In addition to charting the institutional pathways of underrepresented students in STEM fields, institutional researchers are uniquely positioned to employ qualitative methods to understand factors that lead students to select certain pathways. College choice is a complex process influenced by many factors and multiple layers of context (Perna, 2006). Qualitative approaches to institutional assessment are well suited for identifying these significant factors (Harper and Museus, 2007), and the resulting findings, coupled with knowledge gained from quantitative analyses of course-taking patterns, will broaden our understanding of minority students' institutional pathways to STEM.

Identifying Barriers to Transfer Access and Transfer Student Success. This study revealed that Latina/o STEM baccalaureates who attended community college tended to earn their bachelor's degrees from less selective, nonresearch institutions. However, the origins of these patterns remain unclear. Perhaps the problem is one of transfer access to certain institutional contexts. Alternatively, community college transfer students who aspire to major in STEM fields might encounter barriers within highly selective institutions and research universities that have a negative effect on their persistence to graduation. Because the data set I used included only students who earned a bachelor's degree in STEM, I was unable to address this question. Further research at the institutional level can disentangle these issues. Beyond compiling information about the number of community college transfer students admitted to the institution, researchers ought to examine how these students are distributed by field of study and whether these patterns vary by race/ethnicity and gender. Furthermore, it is important to consider ways in which policies and practices related to community college transfer might narrow or even close the pathways to specific STEM disciplines for underrepresented students.

In addition to investigating transfer access, we need additional research to understand barriers that minority STEM majors who transferred from community college might encounter in four-year institutional environments and specific academic departments. Previous research has identified a number of factors that have an impact on transfer student adjustment (Eggleston and Laanan, 2001; Laanan, 2001, 2004, 2007;

Laanan and Starobin, 2004); these should serve as a guide for the development of particularized knowledge regarding students' experiences after transfer and outcomes within various institutional environments. By identifying barriers to transfer access and transfer student success, institutions can be better equipped to improve the pathways to the STEM baccalaureate for underrepresented students who attend community colleges.

Conclusion

Although some may see community colleges as an unconventional route to science and related fields, a significant proportion of Latina/o students are in fact using these institutions as a pathway to the STEM baccalaureate. These students were able to overcome the typical barriers that transfer students and minority STEM majors face. Additional research aimed at characterizing specific ways in which Latina/o STEM majors use community colleges to access more selective four-year institutions will help broaden our understanding of their experiences along these pathways. Increasing resources designed to stimulate interest in STEM fields among Latina/o community college students and providing the academic and institutional support necessary to facilitate transfer and degree attainment will likely widen community college pathways to STEM fields.

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LINDSEY E. MALCOM is an assistant professor of higher education administration and policy at the University of California, Riverside Graduate School of Education.

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