

Pathways to Success: Affirming Opportunities for Science, Mathematics, and Engineering Majors

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Using cross-tabulations, factor analyses, and logistic regressions, this study examined the flow out of and into science, mathematics, and engineering (SME) majors of a cohort of African American, American Indian, and Chicano/Latino undergraduates (N=330) and factors associated with persistence in those majors. The targeted minorities experienced greater attrition from SME majors than did White and Asian Americans. Females from targeted groups showed the largest outflow, followed by their male counterparts. Person-organization "fit" and peer values related to campus activism and engagement were negatively associated with SME persistence. The absence of person-organization fit influence for targeted minorities suggests a need for further study on the relevance of established SME values, educational inequity, self-selectivity, and other influences that limit minority SME representation.

Expanding the pool of scientists and engineers has been a persistent problem for educators and employers alike. Between 1998 and 2008, jobs in science, mathematics, and engineering (SME) fields are expected to increase four times the rate of all other employment opportunities in the United States. This translates into a demand for 1.9 million more trained professionals in these areas (National Science Board, 2000). Presently, White and Asian Americans constitute 82.3% and 10.4% of the SME workforce, respectively, while African Americans, American Indians, and Chicanos/Latinos remain underrepresented in these growing careers relative to their representation in the U.S. population—at 3.4%, 0.3%, and 3.1%, respectively (National Science Foundation, 2000).

Aside from the individual benefits of low unemployment and competitive wages found in SME employment, as a nation we reap rewards by having a workforce that is more representative of all our citizens. Building a more diverse SME workforce has been purported to increase our nation's productivity by boosting the science literacy and multicultural competence of teachers who educate our children (Berryman, 1983); expanding current research on culture-specific illnesses and treatment regimes (Gavaghan, 1995); and capitalizing on the interests of African American, American Indian and Chicano/Latino professionals to serve in poor urban and rural communities (Cantor, Miles, Baker, & Barket, 1996). With people of color representing the majority of students now entering the academic pipeline, the United States is challenged to develop the human capital of African Americans, American Indians, Chicanos and Latinos to meet the continued demand for SME professionals (Thomas, 1992).



BARRIERS TO UNDERGRADUATE PERSISTENCE IN SCIENCE, MATHEMATICS, AND ENGINEERING

For students who major in SME fields, the college degree marks a level of training that is a prerequisite for entrance in medical, research, and other SME professions. However, the literature on science education suggests a domino effect in terms of the challenges faced by students to persist as undergraduate SME majors. Such persistence is directly tied to experiences in K-12 classrooms, with student intentions to major in SME fields peaking by high school and marking a continuous exodus thereafter (Berryman, 1983). For almost all students, inadequate academic preparation is a major factor that limits their achievement in the sciences (Astin, 1993; Berryman, 1983; Oakes, 1990). Courses taken prior to college, such as mathematics, function as sorting mechanisms to identify who will or will not access further training in science, mathematics, engineering and related fields (Sells, 1980). These "sorting" classes present major barriers for African American, American Indian and Chicano/Latino students, who drop out of these subjects as early as elementary school because of tracking and other institutional structures that limit opportunities for rigorous academic preparation (Oakes, 1990).

Despite representing the growing majority of college undergraduates, women are at risk to defer their career goals into non-science fields. Although young women and men show similar aptitude for science through secondary school, women report less interest in SME fields and take less prerequisite courses as they progress through K-12, closing their access to college and graduate training in SME fields (Oakes, 1990). Research has shown that nurturing female interest in the sciences and support from role models such as mothers has long-term influences on women's graduate enrollment in SME fields (Sax, 1996).

Longitudinal studies on undergraduates have shown that the number of students pursuing SME careers declined during college from one in four to less than one in seven students (Astin & Astin). Students who persist in SME majors were found to enter college with adequate mathematical and academic preparation; to participate in laboratory, independent and other hands-on research experiences with faculty; and to join a "critical mass" of peers in these majors (Astin & Astin, 1992).

In addition to understanding the individual characteristics that contribute to student success in SME majors, assessment of the climates or cultures in which students receive their K-12 and postsecondary training in the sciences also helps to explain the impact of these domains on student persistence and achievement in SME. Tobias's (1990) observations highlight the importance of institutional climate in supporting access to SME training in college. Tobias found that a growing population of undergraduates comprised a "second tier" of students whose initial interests and abilities in SME-related disciplines were cooled by poor curricular, instructional, and advising efforts during college. Indeed, the results from one longitudinal study showed that SME faculty were less likely than their peers to include cooperative learning and other teaching strategies shown to engage students more successfully in their learning experiences (Astin & Astin, 1992).

The above findings suggest that student persistence and achievement in SME fields require consistent motivation and strengthening of student interest in the sciences, academic preparation to increase competency in mathematics and analytical thinking, connections with motivated peers who are also pursuing SME careers, and positive interactions with SME faculty on research and independent projects. Taken together, these findings suggest that many factors influence outcomes such as persistence in SME fields for undergraduates. However, more information is needed about the ways in which these factors

interact in specific college environments to affect access, persistence, and ultimately achievement in SME.

SOCIALIZATION IN DYNAMIC ENVIRONMENTS

The present study sought to understand the factors that influence retention of SME majors during college. Its primary premise was that students who selected SME majors as freshmen had persevered through an intensive sorting process at the K-12 level and entered college equipped to meet academic requirements for their intended majors. Though past remediation or lack thereof in specific pre-college courses (e.g., mathematics) may certainly affect long-term student retention in SME at the postsecondary level, a student's academic setting also may influence persistence. Therefore, this study sought to bring current research from the independent arenas of college student development and organizational development to bear on understanding SME retention in dynamic environments.

Findings from a study of college student retention suggest that students may persist in specific college environments, and consequently in subcommunities within college, because of social and intellectual integration (Tinto, 1993). Formal and informal social characteristics (e.g., extracurricular activities and other personal interactions on campus) and formal and informal academic characteristics (e.g., faculty-student learning interactions in and out of class) respectively influence social and academic integration. These factors also directly influence student commitment to persist in college (Tinto, 1993). These characteristics may trigger reactions that result in increased levels of engagement (persistence) or disengagement (withdrawal) in college.

Examination of the process by which individual students engage and disengage in college also becomes an examination of students' intellectual communities, particularly their peer connections. Weidman (1989) suggested that distinct groups such as parents, peers, and faculty shape undergraduates' perceptions of college prior to and during that experience. He further maintained that students constructed either negative or positive perceptions about the college experience based on their interactions and motivations to belong to these various reference groups. For example, students who limit their campus interactions to only members of specific reference groups may find solidarity with and social support from their referent peers if their interactions with them are positive. By contrast, these same students may generalize any negative interactions they have with reference group members under these insulated conditions in ways that threaten student satisfaction with and persistence on the general campus. Indeed, longitudinal studies on undergraduate achievement have shown that the peer group is *the* major influence on students' attitudinal change and development in college (Astin, 1993). From this perspective, socialization is seen as involving some structure of opportunity that provides students with access to various reference groups. For example, an individual student may need to be aware of and have access to a desired group of peers who are focused on college entrance in order to adopt the college-going motivations of this reference group.

"Anticipatory socialization," or the process of taking on the behaviors or characteristics of or identifying with an aspired-to group, often eases an individual's adjustment into future roles and responsibilities (Attinasi, 1989, p. 266). In one study, college preparatory classes, campus visits, and other experiences were found to enable a group of high school seniors to rehearse their roles in a critical "getting ready" phase that facilitated their transitions into college (Attinasi, 1989). Once these students matriculated, their "majoring in" processes initiated them into a focused area of study and provided them with additional means to create communities and identities on campus.

Students often internalize the lessons learned from their socialization interactions. Bandura (1997) suggested that individuals exhibit a form of agency that allows them "to behave differently from what environmental forces dictate rather than inevitably yield to them" (p. 7). He further suggested that students' perceptions about their own self-efficacy enable them to build cognitive models that guide their decision-making and learning processes. In this way, individual agency filters the messages received from peer groups in meaningful ways and enables students to develop independent strategies for success in college.

Student agency and peer group influences combine into a dynamic model to guide students successfully or unsuccessfully throughout their academic experiences. These processes of filtering and sense making occur within many different campus contexts that provide insights on how personal values connect to organizational norms and values to influence specific student outcomes. As suggested by Osipow (1987), the successful attainment of a "fit" between individual characteristics and expected career niche assures success, satisfaction, and advancement. More specifically, the theories of person-organization (P-O) fit developed by industrial psychologists allow the examination of unique as well as combined influences of personal and situational factors on such outcomes as stress (Pervin, 1968), satisfaction (Olsen, Maple, & Stage, 1995), socialization (Chatman, 1991), and attrition (Schneider, 1983). P-O fit refers to a congruence between people and organizations in which "(a) at least one entity provides what the other needs, or (b) they share similar fundamental characteristics, or (c) both" (Kristoff, 1996, p. 50). For example, an organization may attract individuals who share attributes, and representatives of the organization may develop various processes to select individuals who will fit into the organization. They also may ask individuals to leave or provide means of voluntary departure for individuals who are mismatched with the organizational culture, thus resulting in even greater congruence within the organization (Schneider, 1983).

With regard to SME majors in college, it is important to understand how their individual values related to achievement function among the dynamic influences of peers and other reference groups on their campuses. Such study is particularly important given findings from the literature that suggest that student attrition from SME fields in later college years stems from negative experiences in an all-too-often "chilly" climate and other reasons related to voluntary withdrawal (Berryman, 1983; Maple & Stage, 1991; Oakes, 1990).

Conceptual theories related to student development and integration and P-O fit guide this study about possible individual and campus or organizational factors that influence undergraduate students' persistence in SME majors. The literature cited earlier on science and mathematics education suggests that minority students achieve in SME fields because of early interest in these fields, mentorship prior to and during college, and strong academic performance. However, the literature also suggests that African American, American Indian, Chicano/Latino, and other students not representing a critical mass on most campuses in SME fields may experience a poor fit between their values and the norms they perceive being upheld by their peers and other reference cohorts on campus. The chilly climate experienced by these groups may contribute to their departure from SME majors during college.

RESEARCH QUESTIONS AND PURPOSE OF THE STUDY

Two questions raised by the literature will be examined in this study:

- (1) What is the level of departure (outflow) from SME majors among undergraduate students who initially pursue SME courses of study vis-à-vis the level of students' inflow into these majors?

(2) How does value congruence influence persistence in the SME majors among minority undergraduates?

The purpose of this study was to examine the influence of personal, organizational, and unique P-O fit factors on undergraduate minority students' retention in SME majors. Retention in SME was operationalized to describe students' persistence to declare the same SME majors four years after entering college as freshmen. Given the importance of motivations to succeed in college on college achievement, a preliminary hypothesis in this study was that P-O fit or value congruence related to college engagement between minority students and their institutional peer environments influence their undergraduate retention in SME majors.

METHODS

Data Sources and Sample

Data used in this study were drawn from four sources to provide student, institutional climate, and structural organizational information. The student and climate data came from a longitudinal data set collected by the Cooperative Institutional Research Program (CIRP) at the University of California-Los Angeles Higher Education Research Institute. Structural organizational information came from the Integrated Postsecondary Education Data System (IPEDS) survey collected for 1989 by the National Center for Education Statistics (NCES; 1989).

Cooperative Institutional Research Program (CIRP) Data Set. Researchers at CIRP collected data on 192,453 students who responded to its 1985 freshman survey and subsequent follow-up surveys.¹ They administered the 1985 survey instrument to undergraduates enrolling as entering freshmen, and surveyed these and additional students in 1989. The present study employs only those data from the CIRP surveys collected from the same individual at both time points. As the present study was primarily concerned with a prediction of minority student success (defined as retention in an SME major) over time, it used data from a longitudinal sample of entering freshmen who originally responded to the 1985 CIRP freshman survey, who were enrolled full-time in 1985 at either a university or other four-year institution of higher education, and who responded to the 1989 follow-up survey. Selecting by these criteria yielded a general sample of 7,518 cases. From this general sample, two subgroups were created for logistic regression analyses:

- (1) a target sample of African American, American Indian, and Chicano/Latino undergraduates ($N=330$), who were to be the primary focus of these analyses, and
- (2) a comparative peer sample of undergraduates who identified as Caucasian, Asian American, and racial/ethnic backgrounds other than those of the target sample ($N=7,188$).

IPEDS Data Set. The respondents in the final general sample developed for the present study represented 41 institutions of higher education. Institutional data on control type, enrollment, and selectivity were matched by CIRP for these institutions from IPEDS sources for the corresponding survey years.

Instruments

The CIRP survey instrument for entering freshmen included questions on student precollegiate and college values, behaviors, academic achievement, and personal back-

¹See Astin, Parrott, Korn, and Sax (1997) for details on data collection methods, response rates, and reliability related to scales for the respective instruments.

ground. The follow-up survey instruments included questions on the preceding information and related undergraduate study activities and achievement.

Data Analyses

To examine the first research question, descriptive analyses were conducted using the general sample data to identify those among the study population who were SME majors in 1985 and those who remained, transitioned into, or flowed out from these majors in 1989.

Descriptive. Descriptive analyses included means, cross-tabulations, *t*-tests, and correlations used to discern some general relationships among the target sample students with respect to SME retention. Table I shows the means, standard deviations, and correlations for the independent variables for SME majors in 1985 and 1989.

Factor Analysis of Student Integration Measures. To examine the second research question, value measures of social integration (activism) and academic integration (engagement behavior) were developed from data on self-reported activities in which both the target sample and the peer sample engaged in and reported when they responded to the 1989 follow-up survey. Among these, activism, or engagement in social and political causes on campus, is considered in the research literature as an important collective activity among African American, American Indian, and Chicano/Latino students, who view it as a means of establishing peer support groups, a collective voice, and their racial/ethnic identities (Gurin & Epps, 1975). It was also seen as a means of advocating for their inclusion on U.S. campuses nationwide (Gurin & Epps, 1975; Olivas, 1986). For the purposes of this study, such engagement behaviors were seen as contributing to the general interpersonal and academic skill sets that all students must master to effectively network with peers and faculty, gain and demonstrate content mastery, develop identities of themselves as successful students, and develop affiliations with their campuses to encourage persistence (Allen, 1992; Astin, 1993; Tinto, 1993).

Factor analysis was used to identify the underlying dimensions among 26 student behavior items queried on the 1989 follow-up survey. A generalized least-squares extraction method using a varimax rotation yielded five dimensions for value-based student behaviors. This led to the identification of two factors with conceptual links to social and academic integration: FACT, which signified the value-based behavior of activism; and FENGAGE, which signified the value-based behavior of academic engagement. Table II shows the factor loading for these two variables.

The activism factor included two variable scores related to dimensions of activism behavior that were self-reported by entering freshmen in 1989 ($\alpha = .68$): "discussed racial/ethnic issues," and "discussed political/social issues." The academic engagement factor included two different variable scores reported by freshmen in 1989 ($\alpha = .57$): "worked on a group project for class" and "gave a presentation in class." In this manner, social and academic integration variables for the general sample (FACT and FENGAGE) were created and were used in the development of aggregated peer norm scores for the peer sample and subsequent P-O fit scores for the target sample.

Aggregated Peer Group Measures. Two computed variables measured peer norms by the sample institutions. PACT measured peer involvement in activism and FENGAGE measured peer academic engagement. Peer norms rather than calculations of climate emanating from other constituency norms (e.g., faculty) were used, given that peer groups have such potent effects on individual undergraduates in terms of setting and communicating norms and facilitating other aspects of college student socialization. Calculations of behavioral norms for logistic regressions using the target sample included student behav-

TABLE I
Means, Standard Deviations, and Correlations for Independent and Dependent Variables for the General Study Sample

NAME	M	SD	CORRELATIONS*																	
			1	2	3	4	5	6	7	8	9	10								
1. SCI89	1.24	.43	—																	
2. SCI 85	1.32	.47	.60**	—																
3. FEMALE	1.60	.49	-.15**	-.17**	—															
4. INC \$60K+	.77	.42	-.23*	.01	-.07**	—														
5. SAT - MATH	589.70	100.47	.23**	.21**	-.28**	.09**	—													
6. SAT - VERBAL	541.88	98.53	.04**	.03*	-.13**	.09**	.60**	—												
7. HSGPA A/A +	1.28	.45	.19**	.17**	.01	-.01	.35**	.29**	—											
8. UGPA A/A +	1.09	.29	.05**	.03*	.00	.00	.19**	.19**	.26**	—										
9. FACT	4.50	.46	-.03*	-.02*	-.03*	.09**	.45**	.51**	.12**	.04**	—									
10. FENGAGE	4.12	.39	-.06**	-.08**	.05**	-.06**	-.43**	-.43**	-.18**	-.05**	-.05**	—								
11. TARGET ^b	1.04	.20	-.01	.03**	.03**	-.04**	-.10**	-.08**	-.05**	-.05**	.06**	-.09**	—							
12. WHITE	1.89	.31	-.07**	-.10**	-.01	.06**	.01	.05**	-.02	.03*	-.12**	.24**	-.22**	—						
13. ASIAN ^c	1.06	.24	.10**	.10**	-.01	-.01	.07**	.00	.05**	.02	.10**	.10**	-.22**	.79**	—					
14. ISELECT	1124.93	113.18	.05**	.04**	-.06**	.10**	.53**	.54**	.18**	.04**	.04**	.04**	-.60**	-.60**	-.60**	—				
15. IPRIVATE	1.32	.47	-.07**	-.11**	.05**	-.04**	-.08**	-.04**	-.07**	-.04**	-.04**	-.04**	-.23**	-.01	.23**	—				
16. PACT	4.48	.44	-.03**	-.04**	-.02	.08**	.42**	.48**	.10**	.04**	.04**	.04**	-.53**	.99**	.99**	-.53**	—			
17. PENGAGE	4.06	.36	-.07**	-.10**	.05**	-.05**	-.39**	-.39**	-.16**	-.05**	-.05**	-.05**	-.50**	-.50**	-.50**	-.98**	-.98**	—		
18. PFACT	20.00	5.81	-.14**	-.13**	.02	.07**	.25**	.40**	.03	.01	.01	.01	.67**	.67**	.67**	-.35**	-.35**	-.35**	—	
19. PFENGAGE	16.59	4.96	-.10**	-.10**	.07**	-.03*	-.27**	-.27**	-.09**	-.02	-.02	-.02	-.29**	-.29**	-.29**	-.55**	-.55**	-.55**	-.55**	—

(continued on next page)



TABLE I (continued)

NAME	M	SD	CORRELATIONS ^a															
			11	12	13	14	15	16	17	18	19							
1. SCI89	1.24	.43																
2. SCI 85	1.32	.47																
3. FEMALE	1.60	.49																
4. INC \$60K +	.77	.42																
5. SAT - MATH	589.70	100.47																
6. SAT - VERBAL	541.88	98.53																
7. HSGPA A/A +	1.28	.45																
8. UGPA A/A +	1.09	.29																
9. FACT	4.50	.46																
10. FENGAGE	4.12	.39																
11. TARGET ^b	1.04	.20	—															
12. WHITE	1.89	.31	-.03**	—														
13. ASIAN ^c	1.06	.24	-.03*	-.68**	—													
14. ISELECT	1124.93	113.18	03**	-.09**	08**	—												
15. IPRIVATE	1.32	.47	-.07**	12**	-.10**	07**	—											
16. PACT	4.48	.44	06**	-.11**	09**	76**	05**	—										
17. PENGAGE	4.06	.36	-.09**	24**	-.22**	-.53**	32**	-.46**	—									
18. PFACT	20.00	5.81	06**	-.06**	02	50**	06**	68**	-.30**	—								
19. PFENGAGE	16.59	4.96	04**	12**	-.11**	-.29**	17**	-.27**	55**	-.12**	—							

* $p < .05$; ** $p < .05$

^aDecimals are deleted from Pearson correlations.

^bTARGET includes students who identified as African American, American Indian, or Chicano/Latino.

^cASIAN includes students who identified as Chinese, East Indian/Pakistani, Filipino, Hmong, Japanese, Korean, Pacific Islander, Vietnamese, or "Other Asian."

TABLE II
*Factor Loadings for Social Activism and
 Academic Engagement Student Behavior Variables*

	FACTOR LOADINGS	CRONBACH'S ALPHA
ACTIVIST BEHAVIOR (FACT)		.68
Discussed racial/ethnic issues	.69	
Discussed political/social issues	.69	
ENGAGEMENT BEHAVIOR (FENGAGE)		.57
Worked on group project for class	.72	
Gave a presentation in class	.56	

ior scores for the peer sample aggregated by institution to develop peer norms for activism (PACT) and peer norms for academic engagement (PENGAGE).

P-O Fit Scores. A primary interest of this study was to examine the fit or match between the value-based behaviors of students and the peer norms in their specific campus communities. The P-O fit scores measured the interaction between target sample value-based behaviors and peer sample norms. Specifically:

$$P-O \text{ Fit Score} = \text{Target Sample Individual Factor Score} \times \text{Peer Norm Score}$$

This calculation yielded two P-O fit scores: P-O Fit on Activism (PFACT), and P-O Fit on Academic Engagement (PFENGAGE).

Multivariate Logistic Regression Modeling. Two independent logistic regression models tested the hypotheses regarding the associations between positive P-O fit and retention in SME majors in the 1989 sample. The first logistic regression used the target sample and included peer norm computations. The second logistic regression used the non-target sample with that group's own peer norm computations. It was specifically hypothesized that P-O fit on social and academic integration would predict the likelihood of minority students' persistence in SME and possibly other majors.

As discussed by researchers such as Hosmer and Lemeshow (1989), logistic regression models allow the constraints of predicting outcome measures that have binomial distributions to be met when probabilities of membership in one of two exclusive categories are being assessed. Variable coding for the various logistic regression models appears in Table III.

Variable Definitions for Logistic Modeling. Logistic regression models included three types of independent or design variables: student characteristics, institutional characteristics, and P-O measures. The variables for peer norms and for P-O fit reflected climate variables related to the academic contexts in which undergraduates are educated. These climate variables represented the attitudes and prevailing perceptions that provided insight into the diverse academic settings influencing student persistence in SME majors. All dichotomous design variables were given indicator method coding, with the first categories (the "0" values) indicating the reference groups (see Table III).

RESULTS

Characteristics of the General Sample

Table IV provides descriptive statistics for the general sample, approximately 3% of whom declared SME majors in 1985 compared to 24% who declared these majors in 1989.

TABLE III
Descriptions and Codings of the Variables in the Logistic Regression Models

VARIABLE	DESCRIPTION	CODING
<i>STUDENT CHARACTERISTICS</i>		
SME89	1989 Science, Mathematics, or Engineering (SME) Major	0 = no; 1 = yes
COLGPA	"A" or Better 1989 College GPA ^a	0 = no; 1 = yes
FACT	1989 Student Behavior Activism	Computed Score
FENGAGE	1989 Student Behavior Engagement	Computed Score
FEMALE	Student's gender	0 = male; 1 = female
HSGPA	"A" or Better 1985 High School GPA	0 = no; 1 = yes
INCOME	Household Income	0 = under \$60,000; 1 = \$60,000 and over
RACE01	Student Race: SAA	0 = Other; 1 = African American, American Indian or Chicano/Latino
RACE02	Student Race: White	0 = Other; 1 = White American
RACE03	Student Race: Asian	0 = Other; 1 = Asian American
<i>INSTITUTIONAL CHARACTERISTICS</i>		
IPRIV	Private Institution	0 = public; 1 = private
ISELECT	Institutional Selectivity	Average (SATM + SATV) by ACE ^b institutional codes
PACT	1989 Peer Norms for Student Activism	Computed score of non-SME cohorts by each ACE institutional code
PENGAGE	1989 Peer Norms for Student Engagement	Computed score of non-SME cohorts by each ACE institutional code
<i>PERSON-ORGANIZATION (P-O) FIT VARIABLES</i>		
PFACT	1989 P-O Fit for Activism	Computed FACT × IACT
PFENGAGE	1989 P-O Fit for Engagement	Computed FENGAGE × IENGAGE

^aGPA = Grade Point Average

^bACE = American Council on Education

African American, American Indian, and Chicano/Latino students comprised 4% of the general sample of the undergraduate population for this study, while White and Asian Americans comprised 89% and 6%, respectively. Approximately 32% of the undergraduates attended private institutions; 77% reported household incomes of more than \$60,000; and 28% reported high school grade point averages (GPAs) of "A or "A +."

TABLE IV
Cross-Tabulations of Changes in Majors Among Undergraduates Entering College in 1985, by Racial/Ethnic Group Cohorts

MAJOR	TARGET SAMPLE ^a			ASIAN AMERICAN			WHITE AMERICAN		
	1985	1989	% chge	1985	1989	% chge	1985	1989	% chge
Arts/Humanities	78	66	-15.4%	105	117	+11.4%	1103	1151	+4.4%
Business	31	59	+90.3%	30	39	+30.0%	928	1158	+24.8%
Education	24	19	-20.8%	8	4	-50.0%	452	487	+7.7%
Political									
Science	40	43	+7.5%	38	42	+9.5%	866	839	-3.1%
SME ^b	68	38	-44.1%	144	107	-25.7%	1251	945	-24.5%
Social Sciences	28	64	+128.5%	24	84	+250.0%	410	1003	+144.6%
Other Majors	27	20	+185.7%	32	36	+12.5%	584	603	+3.3%
Undecided	34	1	-75.0%	68	0	-100.0%	990	18	-98.2%

^aTarget sample refers to students who identified as African American, American Indian, or Chicano/Latino.

^bSME majors refer to the following majors: agriculture, biological sciences, mathematics and statistics, natural sciences, and engineering.

Persistence, Outflow, and Inflow

The cross-tabulation results shown in Table IV identify the shifts in majors from 1985 to 1989 by racial/ethnic cohorts. African American, American Indian, and Chicano/Latino students with SME majors experienced the largest attrition (-44%) during this period compared to Asian Americans (-26%), White Americans (-25%), and students from "Other" backgrounds (-20%). All racial/ethnic cohorts showed gains in students who declared majors in business and the social sciences. The only majors to experience consistent declines across all racial/ethnic cohorts were the SME and "Undecided" categories. Though this trend is expected for undecided majors, who must eventually declare areas of specialization and outflow from their catchall category, these statistics underscore the rampant attrition specific to SME education.

Cross-tabulation results showed even greater disparities in SME retention when the data were disaggregated by race/ethnicity and gender. The top half of Table IV reports only the actual decline in, or outflow from, SME majors between 1985 and 1989, in numbers and percentages. Table IV reveals that African American, American Indian, and Chicano/Latino female undergraduates showed the largest declines in those in their respective racial/ethnic group who initially declared SME majors in 1985 (-63%). Males from these racial/ethnic backgrounds showed the second highest decline or outflow rates (-53%), followed by White American and Asian American females (-49% each).

When compared to the bottom half of Table V, which shows the inflow of undergraduates from non-SME majors into SME majors, the small numbers from the target sample who entered SME from other fields do not seem to replace those lost due to attrition. A total of 15 African American, American Indian, and Chicano/Latino females and 4 males from the target sample entered SME by 1989 from other majors, representing less than 2% of all undergraduates who declared SME majors in 1989. Only 20 Asian American females and 7 Asian American males entered from non-SME majors during this time, comprising nearly 3% of the undergraduates who switched majors into SME. By contrast, 165 White American females and 89 White American males entered from non-SME majors, ultimately comprising 22% of a total 27% inflow into SME. Though it is disheartening to see that across all racial/ethnic cohorts the SME inflow never balanced nor exceeded those undergraduates who exited these majors, it is clear that White females and males comprised the majority of the new inflow into SME.

Associations Among Student Intentions, Peer Norms, and P-O Fit Measures

The above-noted results explained the high-outflow and low-inflow patterns associated with SME majors. Additional analyses explained how value-based behaviors associated with social and academic engagement influenced persistence for the target and peer samples. For example, the cross-tabulations reported in Table VI showed that the majority of SME majors from the target sample reported low activism behaviors (56%) while the majority of non-SME majors in this racial/ethnic minority cohort reported high activism (58%). This pattern was repeated for undergraduates in the peer sample, with SME majors from that population representing the majority of students indicating low activism (66%) and with non-SME majors in this group representing the majority reporting high activism (54%). Although a majority across all major groups for both the target and peer samples reported low academic engagement, it is interesting that SME majors from the target sample showed a slightly higher percentage reporting high engagement (13%) than did SME majors from the peer sample (6%).

The *t*-test results reported in Table VII show small but significant differences between undergraduate groups on their activism and engagement levels. The mean level of activism

TABLE V
Inflow to SME Majors in 1989, in Numbers and Percentages

	1989 MAJORS IN SME				TOTAL CHANGE (in percents)	
	FEMALE		MALE			
	TARGET SAMPLE ^a (n=211)	ASIAN AMERICAN (n=242)	WHITE AMERICAN (n=3671)	TARGET SAMPLE (n=99)	ASIAN AMERICAN (n=187)	WHITE AMERICAN (n=2533)
OUTFLOW FROM:						
SME ^b	-31 (-63%)	-44 (-49%)	-371 (-49%)	-10 (-53%)	-23 (-43%)	-240 (-48%)
						-49.1%
INFLOW FROM:						
Arts & Humanities	3 (0.3%)	4 (0.4%)	31 (2.8%)	4 (0.4%)	4 (0.4%)	40 (3.4%)
Business	9 (0.8%)	2 (0.2%)	24 (2.2%)	0 (0.0%)	1 (0.1%)	8 (0.7%)
Education	0 (0.0%)	0 (0.0%)	18 (1.6%)	0 (0.0%)	0 (0.0%)	4 (0.4%)
Political Science	0 (0.0%)	4 (0.4%)	2 (0.2%)	0 (0.0%)	2 (0.2%)	0 (0.0%)
Social Science	1 (0.1%)	0 (0.0%)	10 (0.9%)	0 (0.0%)	0 (0.0%)	3 (0.3%)
Unaffiliated	2 (0.2%)	10 (0.9%)	80 (7.2%)	0 (0.0%)	0 (0.0%)	34 (3.1%)
OVERALL INFLOW	15 (1.4%)	20 (1.9%)	165 (14.8%)	4 (0.4%)	7 (0.7%)	89 (7.9%)

^aTarget sample refers to students who identified as African American, American Indian, or Chicano/Latino.

^bSME majors refer to the following majors: agriculture, biological sciences, mathematics and statistics, natural sciences, and engineering.

TABLE VI

Association of Undergraduate Behavior with Persistence in SME Majors for Target and Peer Samples¹
(in percents)

BEHAVIOR LEVEL	TARGET SAMPLE		PEER SAMPLE	
	SME (n=71)	Non-SME (n=259)	SME (n=1738)	Non-SME (n=5,450)
High Activism	43.7	58.3	33.9	50.5
Low Activism	56.3	41.7	66.1	49.5
High Engagement	12.7	10.4	5.7	12.4
Low Engagement	87.3	89.6	94.3	87.6

¹Target sample refers to undergraduates who identified as African American, American Indian, or Chicano/Latino; peer sample refers to undergraduates who identified as White or Asian American or from other racial/ethnic backgrounds.

$p < .00$ for peer sample and $p < .02$ for target sample undergraduates on activism; $p < .00$ for peer sample and $p < .60$ for target sample undergraduates on engagement.

TABLE VII

T-Test Results for Activism and Engagement Variables

	MEAN	SD	t	P LEVEL
<i>STUDENT ACTIVISM (FACT)</i>				
Completing SME majors	4.14	1.00	13.5	.00
Completing majors outside SME	4.52	1.05		
Black, American Indian, and Chicano/Latino Cohort	4.63	1.07	-4.32	.00
Other Students	4.42	1.05		
<i>STUDENT ENGAGEMENT (FENGAGE)</i>				
Completing SME majors	3.90	1.05	7.29	.00
Completing majors outside SME	4.11	1.07		
Black, American Indian, and Chicano/Latino Cohort	3.94	1.11	1.93	.05
Other Students	4.06	1.06		

reported by SME majors ($M = 4.14$) was lower than the mean reported by undergraduates from other fields ($M = 4.52$; $p < .05$). Following the pattern already seen in the cross-tabulation results described above, the mean for activism reported among African Americans, American Indians, and Chicanos/Latinos in the target sample ($M = 4.63$) differed in this regard and was higher than the mean reported by their peers for this factor ($M = 4.42$; $p < .05$). However, both SME majors and undergraduates in the target sample reported lower levels of academic engagement when compared respectively to their peers in non-SME majors and from other racial/ethnic backgrounds.

Results from a logistic regression model for the target sample are reported in Table VIII. Specific to this sample, precollege success (defined as a high school GPA of "A" or "A+" and analytical achievement, as measured by high SAT [Scholastic Aptitude Test]-Math scores) and freshman interest in SME (as noted by indication of intention to major in SME in 1985) were positively associated with enrollment as an SME major in 1989. Attending

TABLE VIII
 Results of Logistic Regression Analysis of Undergraduate Persistence in SME Majors for the Target Sample Cohort Entering College in 1985

DEPENDENT VARIABLE	ASSOCIATION/PREDICTIVE EFFICIENCY	INDEPENDENT VARIABLE	UNSTANDARDIZED LOGISTIC REGRESSION COEFFICIENT (b)	STANDARD ERROR OF b	STATISTICAL SIGNIFICANCE
SME89 (N=211)	$G^2 m = 104$ ($p = .0000$)	High School GPA of "A" or better	.4372	.0962	.000
		SAT-Math Score	.0055	.0006	.000
		1985 Intentions for SME Major	3.5902	.5827	.000
		Institution: Selective	-.0078	.0024	.001
		Constant	-.4907	2.3973	.8378

Hosmer-Lemeshow Goodness-of-Fit Test = 7.21 ($p < .51$; $df = 8$)
 Confidence Table (CT): predicted 85% correct

a highly selective institution was negatively associated with the outcome of enrollment in SME in 1989 ($p < .05$).

Similar to the logistic regression findings for the target sample, logistic regression using the peer sample revealed that the same variables representing precollege success were associated positively with this latter group's enrollment in SME in 1989 (see Table IX). This independent model also showed that high verbal achievement (as measured by SAT-Verbal scores). Even after controlling for individual and peer effects, the model showed a positive association for congruence with peers on activism and congruence with peers on engagement with the outcome variable of persistence in SME majors ($p < .05$).

DISCUSSION

This study focusing on the factors influencing retention in SME majors examined first the patterns of attrition (outflow) from SME during a four-year period and the transfer or inflow of students from non-SME majors into SME majors. The findings from this phase of the study echo empirical evidence found in the literature, which suggests that the exodus of students from these majors exceeds the inflow of students from non-SME majors who eventually transfer into SME fields. Although this trend applied across all racial/ethnic cohorts in the general sample, African American, American Indian and Chicano/Latino undergraduates in the target sample comprised the majority of SME "leavers" and the minority of new entrants into SME as possibly juniors and seniors in 1989.

Logistic regression results showed that high academic achievement prior to college (operationalized as strong high school GPA and SAT-Math scores) and interest in SME majors upon college entrance were factors that were positively associated with SME retention for both cohorts of undergraduates in the target and general samples. These results intuitively make sense because the courses taken to persist in the sciences generally are mathematical and analytical in nature, and they require that students master important mathematics and science prerequisites in high school as the building blocks for their college inquiry in these fields.

Although no peer group (organizational norm) or person-organization fit variables entered the regression model for the target sample, a different measure of the academic climate—institutional selectivity—was negatively associated with SME persistence for this cohort. Institutional selectivity, though signaling a resource-rich environment for most undergraduates, might actually hinder the progress of African American, American Indian, and Chicano/Latino students by constructing what Steele (1992) termed "unwise" school settings (p. 10). He claimed that unwise schools skew their value systems toward the traditional majority, excluding the representation of "other" Americans in mainstream areas like the curriculum and engendering stereotypes that devalue and further marginalize students not considered to be among the prized reference group. Specifically, Steele found that teaching personnel in unwise schools branded certain racial/ethnic or gender cohorts of students as unlikely to succeed. Such teachers placed students' "abilities under suspicion, deflected their ambitions, distanced them from their successes, and painted them with their failures. Black students on today's campuses may experience far less overt prejudice than their 1950s counterparts but, ironically, may be more racially vulnerable" (p. 15).

The data reported in the present study, coupled with Steele's work, provide new insights into the perception that students from backgrounds such as those in the target sample would enter with less academic achievement and continue to decline in their success during college. The findings from this study suggest that academic achievement was important for undergraduates in the target as well as the peer samples. African

TABLE IX
Results of Logistic Regression Analysis to Predict Undergraduate Persistence in SME Majors for Peer Sample Cohort Entering College in 1985

DEPENDENT VARIABLE	ASSOCIATION/PREDICTIVE EFFICIENCY	INDEPENDENT VARIABLE	UNSTANDARDIZED LOGISTIC REGRESSION COEFFICIENT (b)	STANDARD ERROR OF b	STATISTICAL SIGNIFICANCE
SME89 (N=4,724)	$G^2 m = 1895$ ($p = .0000$)	High School GPA of "A" or better	.4372	.0962	.000
		SAT-Math Score	.0055	.0006	.000
		SAT-Verbal Score	-.0018	.0006	.003
		1985 Intentions for SME Major	2.9275	.0908	.000
		P-O Fit: Activism	-.0679	.0085	.000
		P-O Fit: Engagement	-.0337	.0094	.000
		Constant	-3.1560	.3978	.000

Hosmer-Lemeshow Goodness-of-Fit Test = 16.94 ($p < .03$; $df = 8$)
Confidence Table (CT): predicted 85% correct

American, American Indian, and Chicano/Latino students who enter SME majors in selective college environments where they are expected to fail in the major will fulfill this prophecy in droves.

Showing congruence with the target sample students on the higher activism and evidencing slightly higher social integration behaviors negatively influenced retention in SME for the students in the peer sample. This suggests a further difference in the models for success for African American, American Indian, and Chicano/Latino students and their White and Asian American student peers. Though "discussing racial/ethnic issues" and "working on group projects with peers" may certainly consume valuable time and possibly distract SME majors from their experiments and studies, spending time to develop these social dimensions might not be the negative distractions they are initially perceived to be. For example, it is possible to believe that as future physicians working with immigrant populations or future civil engineers working on urban planning, students with backgrounds such as those of the students in the peer sample would need a deeper understanding of the diverse communities that they would serve. Orfield and Whitla's (1999) research confirmed this, reporting that law students found that exposure to more inclusive experiences and curricula during their training equipped them with unique skills to address important areas of their future responsibilities. In a sense, multicultural training provides mainstream students with opportunities for enhanced understanding of those beyond their own racial/ethnic borders. It also provides them with interpersonal skills to help them work more effectively in collaboration with persons from diverse communities.

Implications for Research

Assessing organizational climates in the way posited by this study connects empirical evidence on individual and institutional influence on student persistence to the broader study of the college context as a dynamic environment. These findings suggest some tentative strategies that might be used in assessing the nebulous influence of domains such as the culture or climate of students' environment. They further highlight the need to examine contextual factors more extensively and to devote both time and resources to expanding institutional research efforts into such critical majors as SME.

Both the methodology used in this study and the findings obtained present many avenues for future study, not the least of which includes identifying better ways to operationalize institutional climate and culture variables. Though the computation of person-organization fit worked well as a means of measuring congruence for the peer sample, a more sensitive measure or strategy for measurement may be needed to assess fit among people of color and other marginalized groups pursuing SME degrees. Put simply, understanding the fit between a similar target sample and majority-culture norms may require studying the fit that takes place either much earlier in this sample's academic tenure or along different dimensions. Additional study in this area should provide some insights into new methodology to meet these goals.

Implications for Policy and Practice

The findings from this study tentatively suggest that, for SME majors, having value congruence with students outside of their disciplinary communities with regard to social and academic engagement on campus decreased the probability of their persisting in these majors. Although the "fit" may be for values heralded on campus (e.g., engagement in multicultural activities), this congruence may further marginalize subgroups or SME majors from the prevailing values in their disciplines. The literature exemplifies the conundrum in which most people of color and women find themselves when pursuing SME

majors. For example, both female persisters and nonpersisters in SME have communicated "war stories" about the layers of marginalization they often must endure as members of groups who are underrepresented in SME fields. Many have also spoken of being ostracized by their referent peers (e.g., women being criticized by male peers) when they embraced values of the majority group (Seymour, 1995). In SME fields in which traditions and practices are set by an elite few, broadening organizational norms to perceive of SME education in new, more inclusive ways may even threaten the success of majority group students who attempt such transformation (Zuckerman, 1977).

Nevertheless, the exploratory nature of this study raises a major question for educators about how to provide academic environments that foster minority students' persistence in SME (and other) majors when value systems, both individual and disciplinary climates are in states of flux. As Boyer (1989) has suggested, college is a time when students are free to explore both their vocational aspirations and their personal belief systems. In relation to the findings of the present study, educators may need to provide African American, American Indian, and Chicano/Latino students, particularly those pursuing SME majors for which attrition is high, with opportunities to help them better understand the climate and culture they will experience in college and in SME-related professions. In addition, educators should identify ways in which SME professions would benefit from broadening their current values and practices so that students perceive a more welcoming environment for study. These strategies could include providing more extensive orientations to new and transferring students as well as offering a variety of mentorship and apprentice opportunities to further validate the involvement of students of color in SME majors and provide them with a wide network of supportive mentors.

The nation's colleges may need to provide more fluid environments to spur debate and discussion on these topics by opening up the dialogue to persons with different opinions and perspectives. Such self-examination may not only improve student satisfaction and development during college but may also increase the responsiveness of postsecondary institutions in efforts to conceptualize SME education in more useful and relevant ways for diverse groups of students and practitioners.

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