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"We Do Science Here": Underrepresented Students' Interactions with Faculty in Different College Contexts

Abstract

Faculty members play a key role in the identification and training of the next generation of scientific talent. In the face of the need to advance and diversify the scientific workforce, we examine whether and how specific institutional contexts shape student interactions with faculty. We conducted a mixed methods study to understand institutional contextual differences in the experiences of aspiring scientists. Findings from a qualitative five-campus case study and a quantitative longitudinal study of students from over 117 higher education institutions were analyzed to determine how aspiring scientists interact with faculty and gain access to resources that will help them achieve their educational goals.

Introduction

It is a critical national priority to develop, recruit, and retain talent in science and engineering in order to maintain U.S. economic competitiveness in the context of rapid globalization. In its report titled *Rising Above the Gathering Storm,* the National Academies' Committee on Science, Engineering and Public Policy (2007) issued a strong call to action that resulted in the passage of the 2007 America Competes Act to strengthen science-related education, programs, and research. However, the report did not address the substantial gaps between growing racial/ethnic groups or pose recommendations to address how the production of scientists may be affected by the culture of science within institutions with substantially different resources. The underrepresentation of racial/ethnic minorities is not necessarily attributable to a lack of interest in science fields, but rather poor degree completion rates. For example, Huang, Taddese, and Walter (2000) found that underrepresented minorities had lower persistence rates (26%) in science and engineering than their White and Asian American counterparts (46%). Although student preparation and ability are important, progress through the scientific pipeline may be strongly influenced by the types of opportunities, experiences, and support students receive in college.

Diversifying the scientific workforce has remained an important goal for both the National Science Foundation (NSF) and the National Institutes of Health (NIH). NIH initiatives, in particular, have provided funds to support undergraduate research training in institutions that graduate a large number of science baccalaureates from diverse racial/ethnic and socioeconomic groups. These funds are intended to assist with both individual training and to compensate for institutional resource differences in colleges

where large numbers of underrepresented racial minority (URM) students are educated. Even with these programs in place, students may abandon aspirations long before they declare a science major. Questions arise as to whether certain student experiences provided by colleges are more effective in science training and in retaining underrepresented groups. To address this issue, this study examines whether and how specific institutional contexts shape student interactions with faculty. Specifically, we draw from quantitative data on students' first year experiences and qualitative data from upper-division students to identify how the educational context affects the nature and frequency of science students' interactions with faculty. We chose to focus on this type of interaction because students' connections to faculty have been shown to be an important source of recognition and encouragement for navigating through the undergraduate science pipeline (Astin, 1984, 1993; Carlone & Johnson, 2007). Faculty members also serve as an important resource for students' access to opportunities due to their role in recognizing talent for scientific work.

Review of the Literature

Individual and Contextual Factors Affecting Student-Faculty Interactions

A number of individual characteristics and contextual factors influence the quality and frequency of student-faculty interactions in college (Astin, 1993; Cole, 2007; Kuh & Hu, 2001; Pascarella, 1980; Pascarella & Terenzini, 1991; Phelan, 1979). For instance, Kuh and Hu (2001) found that Black students reported more frequent and substantive student-faculty interactions than other students. According to them, students' contact with faculty members was more frequent among upper-division students, which may result from enrollment in a larger number of smaller, upper-division classes in a student's

major, growth in students' intellectual and academic abilities, and greater faculty receptivity of older, more advanced students. Additionally, Ku and Hu found that students' academic preparation and performance positively predicted the frequency of their interactions with faculty. It should be noted, however, that their study had a cross-section of students and a limited sample of Black students.

In a more recent study, Cole (2007) found racial differences in students' propensity to report having interacted with faculty. Specifically, Asian Americans and Black students were less likely than their White peers to enter into a mentoring relationship with a professor. Moreover, White students were more likely to interact with faculty during class. Cole also found that gender (female), mother's level of education, and average high school grade point average positively predicted course-related student-faculty contact. Because students' first year experiences affect their chances of advancing along scientific educational pathways, it is important to investigate the nature of faculty-student interactions at an early stage in students' course of studies.

In examining this type of interaction, Cole's (2007) study also makes clear the importance of accounting for "accessibility cues." According to Wilson, Woods, and Gaff (1974), the actions of faculty members in the classroom provide students with cues concerning the accessibility of faculty outside of the classroom. In other words, they claim that "faculty who have little contact with students do little to invite such contact, indeed may do much to discourage it" (p. 85). In his study, Cole (2007) examined the impact of four independent variables that he considered to be accessibility cues: "felt bored in class," "challenged professor's ideas in class," "professor didn't take my comments seriously," and "worked on a group project in class." Cole (2007) found that

students who felt bored in class and believed that their professor did not take their comments seriously had significantly reduced course-related contact with faculty and reported a lower likelihood of establishing mentoring relationships with faculty. By contrast, students who challenged a professor's ideas in class and worked on group projects in class reported significantly more frequent in-class interactions with faculty. These findings suggest that the signals students receive from faculty in classroom settings can significantly influence the quality and frequency of their future interaction with faculty both in and outside of the classroom.

Given the possibility that the quality and frequency of faculty interaction vary by race, the question arises as to whether URM students are better served in specific college environments or whether structured variation in students' experiences within college environments can facilitate their development of relationships with faculty. Kraft (1991) found that Black students at predominantly White institutions (PWIs) may be especially susceptible to feeling intimidated by their faculty. Likewise, Nora and Cabrera (1996) found that minority students who perceived a more discriminatory campus climate were less likely to have positive experiences with faculty. Prior research also has indicated that underrepresented students' experiences with faculty contribute to their perceptions of the campus racial climate (Hurtado, 1994). However, in a study of a predominantly White public university in California, Loo and Rolison (1986) found that, despite the fact that minority students experienced greater levels of sociocultural alienation than White students, White and racial minority students had little difference in their perceptions of faculty support. Although it was a single institution study, the researchers found that faculty levels of acknowledgement for students' class contributions and students' degree

of comfort about raising questions did not significantly differ based on students' minority status.

In contrast, multi-institutional studies have indicated that the experiences of students at minority serving institutions (MSIs) can differ significantly from the experiences of their counterparts at predominantly White institutions (PWIs). For instance, Allen (1992) and Nelson Laird, Bridges, and Morelon-Quainoo (2007) found that African American students at Historically Black Colleges and Universities (HBCUs) reported greater levels of engagement, higher academic performance, and more favorable relations with professors than their African American peers at PWIs. Nelson Laird et al. (2007), however, did not find a similar pattern of results when comparing experiences of Latino students at Hispanic-serving institutions (HSIs) to Hispanic students at PWIs. More specifically, the results of their study did not show any statistically significant differences between the two groups in the frequency with which grades, readings, and career plans were discussed with faculty; the likelihood of receiving prompt feedback from faculty; or the chances of working with faculty outside of class. Studies have been unable to capture distinctive effects for Latinos or even whether they have more contact with Latino faculty, as Black students do with Black faculty at HBCUs. However, at least one study (Dayton, Gonzalez-Vasquez, Martinez, & Plum, 2004) has suggested that, for some Latino students, the race of a faculty member was not as important to them as the faculty member's ethic of caring.

The Impact of Faculty Interactions for Students in STEM Majors

Based on research highlighting the supportive nature of HBCUs, it is not surprising that these colleges and universities serve as a significant pipeline for the

production of minority scientists and engineers. Perna, Lundy-Wagner, Drezner, Gasman, Yoon, Bose, and Gary (2009) report that HBCUs produce approximately 22% of all bachelor's degrees earned by Black students but account for 30% of all STEM degrees earned by Black students. Black STEM students who attended an HBCU as an undergraduate tended to enroll in graduate STEM programs at higher rates than their counterparts at PWIs (Wenglinsky, 1997).

It may be the case then that URM students majoring in STEM disciplines at PWIs are less likely to receive adequate levels of racially and culturally relevant support. According to Johnson (2007), several departmental practices and values serve to discourage minority women in the sciences, which may be instructive for considering key differences in URM support across institutions. Johnson found that conducting classes in large lecture halls made the students feel like a "face in a crowd" (p. 811). In addition, Johnson argued that professors' practice of asking questions during their lecture disadvantaged students who were taught to avoid attracting attention in classes. Johnson also pointed out the problem associated with a "narrow focus on decontextualized science" (p. 814), whereby the lived experiences of students are not made a more integral part of the process of learning science, which makes it more difficult for students to identify with the course content. Lastly, Johnson discussed the problems associated with the false assumption that the science classroom is meritocratic and race, ethnicity, and gender neutral. When departments fail to account for how the learning environment may be more negative for women of color, for example, it likely discourages women from further pursuing their studies. Although Johnson only studied one institution, she

identified several important issues that should be considered when examining student-faculty interactions in science courses.

The body of research concerning science education also stands to benefit from a broader conceptualization of how individual and institutional factors impact the lives of developing scientists. Carlone and Johnson (2007) recommend focusing on the development of science-identity as a useful lens to interpret the experiences of URMs and women. According to them, exploring science-identity can provide a better understanding of the cognitive and social processes surrounding learning, which gives researchers the tools to re-conceptualize "a more equitable science education" (p. 1189). Carlone and Johnson developed a conceptual model of science identity, which included three overlapping components of performance, recognition, and competence. Their theory suggests that a disruption of a student's science identity may occur through feelings of being "overlooked, neglected, or discriminated against by meaningful others within science" (p. 1202). These "meaningful others" include individuals who have power over a student's academic career, and they are typically faculty members, although recognition from peers and graduate students may also be important. Thus, under Carlone and Johnson's framework, student identity as a developing scientist is informed by student-faculty interactions that represent the norms of the culture of science within institutions.

Norms surrounding science play an important role in defining the culture of science in specific institutions. Becher's (1989) work on cultures of academic disciplines explains how the culture of science may serve as a disrupting source for the development of science identities among URM students. Becher contends that "academic tribes" define "their own identities and defend their own patches of intellectual ground by employing a

variety of devices geared toward the exclusion" of others that do not fit their ideal (p. 24). These devices include the creation of folklore, myths, and legends by academic disciplines. According to Becher, "These legendary aspects of a disciplinary culture have incidentally a wider role: they serve not only as part of the machinery of socialization, but also as weapons to be deployed in the course of internal disputes and controversies." Becher maintains that "initiates," which include undergraduates, "are steeped in a folklore and a code of accepted or required practice which conditions the way they see the world," whereas disciplinary culture is "gradually shaped through the interaction of students with one another, with their instructors, and with their work" (p. 25).

Driver, Asoko, Leach, Mortimer, & Scott (1994) argue that the culture of science has two primary tenets. The first speaks to the collective "culture" that dictates those practices deemed acceptable within the discipline of science. The second is individualistic in that it refers to how an individual practices science; this tenet, according to them, emphasizes the way in which students are "being initiated into scientific ways of knowing" (p. 6). Students thus gain exposure to scientific culture and are actively taught or shown the way in which "science is done," having to navigate both areas within their university-specific setting. Preliminary research reveals that the culture of science is not only experienced differently in coursework and in work on scientific projects with faculty but also that these distinctions are informed by the overall institutional ethos (Hurtado et al., 2009).

Given the importance of faculty interaction in shaping students' experiences in their disciplines and the literature reviewed above, the current study assumes that faculty have a critical role in shaping the culture of science on a campus and that undergraduate

contact with faculty is an important part of their socialization in becoming a scientist. We examined the effects of specific institutional contexts on this socialization process, as prior researchers have concluded that institutional culture, in addition to disciplinary culture, matters for preparing future scientists (Allen, 1992). Additionally, we examined how out-of-class interactions with faculty, through structured undergraduate research programs, assist URM STEM students in overcoming some of the challenges they face associated with perceived negative aspects of their studies (Johnson, 2007). To address these issues, we tested a model of potential predictors of student-faculty interaction for aspiring scientists and drew from accounts of students who have successfully navigated their way into a major.

Methods

To examine the institutional contexts and students' characteristics and experiences that increase the chances of interacting with faculty, we employed a sequential explanatory strategy, whereby quantitative data were collected during the first phase of research followed by the collection of qualitative data in the second phase. According to Creswell (2003), the qualitative data and analyses in a sequential explanatory strategy provide support for the quantitative findings and offer "broader perspectives as a result of using the different methods as opposed to using the predominant method alone" (p. 214). The following sub-sections first describe the quantitative techniques used in this study and conclude with a description of the qualitative methods.

Quantitative Methods

Sample. The quantitative sample comes from two surveys administered by the Cooperative Institutional Research Program (CIRP): the 2004 Freshman Survey and the 2005 Your First College Year (YFCY) survey. Students in our sample completed the 2004 Freshman Survey as they entered college in the fall of 2004. During the spring term of 2005, we followed up with these same students as they completed their first year of college. Details of the sampling and weighting procedures may be found in Hurtado, Han, et al. (2007) and Hurtado, Eagan, et al. (2008). Because this study focuses on students' experiences and the institutional characteristics that affect the frequency with which biomedical and behavioral science students interact with faculty, we limited the quantitative sample to 3,003 aspiring scientists across 117 institutions who answered both the Freshman Survey and YFCY survey. Analyses of the demographic characteristics of the sample show that 78% of respondents were women. Approximately 30% of students identified as Black or African American, 21% as Latina\o, 11% as Asian, 4% as American Indian, and 34% as White. Approximately 55% of the institutions in the study were privately controlled. HBCUs accounted for 13% of institutions in the sample, whereas Hispanic-Serving institutions (HSIs) accounted for 9% of the institutions.

Variables. The dependent variable in the quantitative analysis measured students' self-reported frequency of interacting with faculty during their first year of college. This factor included students' responses to four survey items, which were identified based on principal axis factoring with promax rotation from a set of YFCY 2005 survey items that included: frequency of interaction with faculty during office hours; frequency of interaction with faculty outside of class or office hours; frequency with which students

received advice from faculty about their educational program; and frequency with which students received emotional support from faculty. These items had a Cronbach's alpha coefficient of 0.68, which meets the reliability threshold recommended by Pedhauzer and Schmelkin (1991).

Table 1 shows all of the measures and scale ranges in the quantitative analysis. The independent variables in our analyses accounted for students' demographic traits, prior academic preparation, college entry characteristics, and first-year college experiences. The set of variables that targeted prior academic preparation included students' self-reported high school grade point average (GPA), the frequency with which they interacted with teachers in high school, and whether they participated in a pre-college summer research program. Additionally, we controlled for students' sense of connection with their intended science major through a factor labeled 'science domain identification,' which tapped into students' life objectives, including wanting to make a theoretical contribution to science and wanting to be recognized for contributions to their field. The science domain identification factor has a Cronbach's alpha of 0.71.

Given that students' activities and experiences during the first year of college likely affect their level of interaction with faculty, our analyses also statistically controlled for a number of student perceptions and activities, including their perceptions of faculty members' treatment of students, level of participation in faculty research projects and departmental clubs, as well as whether they received negative feedback about academic work. Additionally, our analyses accounted for students' success at managing the academic environment, the extent to which students felt they belonged to the campus community, and the frequency with which they interacted with students of

other races and ethnicities (see Hurtado et al. [2007] for more information about these factors). The final block of variables in the analyses controlled for the uniqueness of students' own campus characteristics and climate (measured by aggregating key student-level variables for each institution).

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Analyses. To examine separately the individual and institutional effects on students' frequency of interaction with faculty members, we utilized hierarchical linear modeling (HLM). According to Raudenbush and Bryk (2002), HLM appropriately partitions variance to the individual (student) and group (institution) levels when data are clustered. By separating variance attributable to student effects and to institutional ones, HLM provides more robust, reliable estimates for institution- and student-level predictors than do single-level statistical techniques, such as ordinary least squares (OLS) regression; therefore, utilization of HLM reduces the risk of making a Type I statistical error.

For HLM to be appropriate, the outcome variable must have substantial variation within and across institutions. To determine the proportion of variance attributable to institutional effects, we computed the intra-class correlation (ICC) per Raudenbush and Bryk's (2002) recommendation and found that 15.4% of the variance in students' interactions with faculty was due to institutional effects. Given this relatively high ICC, we proceeded with the use of HLM.

Because this study focuses on student and institutional predictors of students' interactions with faculty, we chose to grand-mean center all of our continuous variables at level-1 except for those variables being modeled with level-2 predictors. All level-1

predictors that significantly varied across institutions were group-level centered. We left all dichotomous variables un-centered.

Qualitative Methods

Site Selection. To better understand students' experiences with science in different contexts, we went to five different campuses located in different states across the U.S. Taken together, we conducted 10 focus groups and 16 interviews with science faculty and key administrators of undergraduate science research programs. The campus case study sites, which included two PWIs, two Hispanic Serving Institutions (HSIs), and one HBCU, were purposefully selected because they offered formal undergraduate science research programs and have high rates of science degree completion. This sampling strategy strengthened the study by offering insights into key similarities and differences across various institutional contexts. Participants in both the student focus groups and individual faculty/administrator interviews were purposefully recruited through science undergraduate research programs. We utilized purposeful sampling in order to capture "information-rich cases that elicit an in-depth understanding of a particular phenomenon" (Jones, Torres, & Arminio, 2006, p. 65), and specifically to capture the experiences of students who had successfully navigated the scientific pipeline.

Table 2 provides a description of each campus site. Southern State University (SSU) is a master's comprehensive university ranked nationally among the highest number of baccalaureate degrees awarded to Latina/os in the biological sciences. Southwestern Flagship University (SWFU) is a research university that offers doctoral degrees in the sciences and in the schools of engineering, medicine, and pharmacy. Latina/o students comprise more than a third of the undergraduate enrollments. Southern

Private University (SPU) is a relatively small HBCU, and its undergraduate enrollment is approximately 75% Black. While SPU offers a small number of graduate degrees, and it boasts a relatively large school of pharmacy, SPU's strong focus on undergraduate education has made it a national leader in African American baccalaureate degrees in the biological and physical sciences.

Western University (WU) is a large, public, research university with a prominent medical school. WU is ranked nationally among the best institutions in engineering and research in the biological sciences. The student population is predominantly White and Asian American, and a large proportion of WU's undergraduate students are biological science majors. North East University (NEU) is an elite research university consistently ranked among the top doctoral degree granting institutions in the country. The undergraduate population is also predominantly White and Asian American, but it also maintains high ranking among the top producers of URM degrees in science.

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Interviews. Focus group interviews, ranging from 45 to 90 minutes, were conducted in two sessions with 2 to 12 participants per session. Each focus group session was conducted by at least two researchers, with one or two facilitating the discussion while another took notes. The 71 student participants represented a racially diverse group: 56% Latina/o, 18% Black, 13% Asian American, 8% multiracial, 2.5% American Indian, and 2.5% White. Women constituted 60% of the sample, and the majority of students (70%) were biology, biochemistry, or chemistry majors.

We also conducted 45- to 90-minute individual interviews with a faculty member or administrator affiliated with an undergraduate research program on campus (e.g.,

Minorities Accessing Research Careers [MARC]). The sample primarily consisted of coordinators, assistant directors, and directors of science research programs but also included science faculty and upper-level campus administrators. For both sets of interviews, we employed a semi-structured protocol, which addressed the following broad thematic categories: types of support offered by the program, program evaluation, students' interest in science, educational and careers goals, undergraduate research experience, and obstacles facing URM students.

Analyses. Each site visit lasted between one and two days. At the end of each visit, we compiled notes from interviews, campus documents, and observations in a single notebook along with supplemental institutional documents. These documents provided the basis for triangulation across multiple sources of data (Creswell, 2003). We recorded and transcribed all interviews. Using a pattern matching technique (Yin, 1994), we coded transcriptions and organized the results using NVivo® software to identify emergent themes across the distinct interviews and campuses (Bazeley, 2007). According to Jones, Torres, and Arminio (2006), "a theme is most commonly understood to be an element that occurs frequently in a text or describes a unique experience that gets at the essence of the phenomenon under inquiry" (p. 89). Three to four researchers separately coded randomly-selected sections of text, and reliability results were calculated by dividing the number of commonly coded passages by the total number of passages coded in each transcript. This process was repeated until the researchers consistently reached acceptable inter-coder agreement levels between 75 and 85 percent (Miles & Huberman, 1994). The multi-institutional analysis allowed for validation of the findings across sites,

whereas the multiple focus groups per school allowed for cross-validation of findings within institutions (Yin, 1994).

Cross-site comparisons were conducted across the five different institutions to examine how faculty, staff, and students involved in undergraduate research programs made sense of the process related to "becoming scientists" in different college contexts. According to Miles and Huberman (1994), cross-case analyses permit us to "deepen understanding and explanation" (p. 173) of a particular experience. The use of cross-case comparisons allowed us to examine more deeply the types of structural elements in place, such as faculty approachability and their ethic of care for students that facilitated student-faculty interactions and students' development as scientists. In short, these analyses add to the largely individualistic focus common among previous research on science students by also focusing on how institutional contexts contribute uniquely to diversity in the scientific workforce.

Limitations

The mixed method design is intended to make up for some of the shortcomings in each of the quantitative and qualitative components. For example, the generalizability of the qualitative five campus sample is limited, but the quantitative data help by extending the sample to 117 institutions. The quantitative data alone, however, cannot provide enough information about how students experience science in these contexts and therefore is aided by specific examples and themes generated by the qualitative data. Other limitations include the fact that the sample for the quantitative portion of the study was overrepresented by women and the longitudinal response rate between the Freshman Survey and the YFCY survey was 22.5%. To attenuate non-response bias we developed

normalized response weights to approximate the responses of the entering freshmen classes at institutions where both surveys were administered to the entire cohort or a random sample of the cohort (for additional information on the weighting procedure used, see Hurtado et al. [2007]). Additionally, it is important to note that we collected the quantitative data from first-year students whereas the qualitative data came from interviews of students in their third and fourth year of college. Students who successfully navigated their way into the major and an undergraduate research program may not have experienced some of the barriers that other freshmen have experienced. It is important to note, however, that even these successful students did not hold uniformly positive assessments of their experiences in science on their campuses.

Results and Discussion

Table 3 presents the results from the HLM analyses. For the sake of simplicity, only the results of the final (i.e., intercept and slopes as outcomes) model are presented. Overall, the level-1 predictors accounted for approximately 28% of the variance in faculty interactions attributed to student characteristics. The level-2 model accounted for nearly 61% of the variance in the outcome attributed to institutional characteristics. Combined, the models accounted for slightly more than 33% of the total variance in students' interactions with faculty during their first year of college.

We examined three student-level predictors that significantly varied across institutions (cross-level interactions): the effect of being Black, participation in a pre-professional or departmental club, and working on a professor's research project. In Table 3, the main effect of these cross-level interactions is presented first followed by the institutional characteristics that either enhance or mitigate the strength of the student-

level effect. For example, we found significant variation across institutions for the effect of being a Black student on student-faculty interactions. This significant variation indicated that Black students appeared to experience a unique impact on their propensity to interact with faculty based on where they attended college. To examine what accounted for this variation across institutions, we used institutional predictors to create cross-level interactions with the slope associated with Black students. In other words, we used institutional variables to assist in explaining what college contexts either encourage or discourage Black students' frequency of interaction with faculty. Black students, on average across institutions, had less frequent interactions than White students ($b = -0.79$, $p < 0.05$); however, cross-level interaction terms revealed that Black students who attended an HBCU ($b = 0.62$, $p < 0.001$), a more selective institution ($b = 0.35$, $p < 0.01$), and a larger institution ($b = 0.33$, $p < 0.05$) interacted with faculty significantly more often than their Black peers at predominantly White, less selective, and smaller institutions, respectively. In other words, these three institutional contexts (HBCU status, selectivity, and size) appear to mitigate first-year Black students' propensity to interact less frequently with their professors. It is important to note that these effects are evident after controls for ability and other college experiences and institutional characteristics are introduced. By contrast, after controls were introduced, Latina/o students did not exhibit any significant differences in interaction with faculty compared to White students nor was attending an HSI significant in the model, indicating no further investigation was necessary.

A second cross-level interaction shown in Table 3 relates to the variability of the effect of participating in a pre-professional or departmental club on students' frequency

of interaction with faculty. Students who participated in these clubs appeared to interact with faculty significantly more often than their peers who did not join these organizations ($b = 0.46$, $p < 0.001$). Students who attended institutions where their peers had a stronger connection to science tended to reap even greater advantages from participation in departmental clubs ($b = 0.38$, $p < 0.05$). Likewise, students who joined these clubs and who attended institutions where more students reported that faculty treated them "like numbers in a book" tended to report even higher levels of interaction with faculty. It may be that, on campuses where a large proportion of students experience a strong sense of anonymity perhaps because of large institutional or class size, these academic clubs provide more opportunities to connect with faculty in purposeful and structured ways. The final institutional moderator related to participation in academic clubs is an institutions' level of research expenditure. Unlike the other variables, increasing research expenditure tended to reduce the strength of academic club participation and the frequency with which students interact with faculty ($b = -0.02$, $p < 0.05$).

The final cross-level interaction we examined in the analyses related to the effect of working on a professor's research project. On average, as students spent more time working on a professor's research project, their frequency of interacting with faculty increased significantly ($b = 0.22$, $p < 0.001$). Attending an institution that spends more money on research activities appeared to strengthen the effect of working on a professor's research project. Perhaps these better resourced institutions provide financial incentives to students who participate on faculty research projects, as students at better resourced institutions might receive stipends for their work on research projects. This

finding may also relate to recent grant policies that provide additional stipends for undergraduate research training incorporated into specific research projects.

In addition to these cross-level effects, we identified a number of significant institution-level variables that affected the average frequency of students' interactions with faculty (as indicated by the intercept in the model). On average, students who attended more selective institutions tended to interact with faculty significantly less frequently than their peers did at less-selective colleges and universities. A 100-point increase in institutional selectivity resulted in almost a half-point reduction in the average student's interaction with faculty ($b = -0.47$, $p < 0.001$). Likewise, students who enrolled at larger institutions tended to interact with faculty significantly less often than their peers at smaller institutions ($b = -0.74$, $p < 0.001$). Finally, students who attended institutions where their peers, on average, perceived that faculty treated them "like numbers in a book" tended to interact with faculty significantly less often than their counterparts at colleges and universities where students, on average, perceived that faculty treated them as individuals ($b = -0.89$, $p < 0.05$).

Curiously, students' individual perception (student-level) that faculty treated them "like numbers in a book" had no significant effect on their propensity to interact with faculty, but other student-level characteristics and experiences did have a significant effect. Students' self-reported level of interacting with faculty in high school had a positive effect on their level of interacting with faculty in college ($b = 0.31$, $p < 0.001$). Similarly, students who reported feeling that their college faculty cared about their personal ($b = 0.48$, $p < 0.001$) and academic ($b = 0.20$, $p < 0.05$) problems also had higher frequencies of interacting with their professors during their first year of college.

Being academically engaged, as measured by time spent studying ($b = 0.10$, $p < 0.01$), discussing course content with students outside of class ($b = 0.29$, $p < 0.001$), or participating in an academic enrichment program geared toward minority students ($b = 0.30$, $p < 0.01$), tended to also increase the chances that students would interact more frequently with faculty.

By contrast, students who were struggling academically also interacted more often with faculty. Students with lower first-year cumulative GPAs tended to report interacting with faculty more often than their peers with higher GPAs ($b = -0.14$, $p < 0.01$). Likewise, students who reported that they received negative feedback from faculty about their academic work also tended to report more frequent interactions with their professors ($b = 0.25$, $p < 0.001$). It appears then that first-year students who need more academic assistance are also reporting to be interacting more with faculty, but the nature of this interaction is likely different from those students who are more engaged academically by, for example, participating in faculty research.

Although analyses of the data collected from interviews and focus groups uncovered a number of themes, we focus only on the themes salient to students' interactions with faculty across different institutional contexts. We provide information based on three themes: faculty approachability, students' views about an ethic of care (as opposed to being treated "like numbers in a book"), and how faculty seem to balance rigor and support for students. These themes were drawn from student, faculty, and program administrator interviews. Then we review some of the contextual differences related to faculty accessibility and support both inside and outside of the classroom.

Faculty Approachability. Upon first entering college, students described feeling intimidated about approaching faculty. While this concern was common among nearly all students who had successfully navigated into the major, the intensity also varied to a certain degree across the five institutions, with students perceiving faculty to be most approachable at SPU and least approachable at NEU. A student at a NEU commented that, "Just recently, maybe last year, I started talking to a few of my professors when after class I didn't understand something, but it took me two years to finally do it." Some students in our focus groups reported that they developed a reluctance to approach faculty over time after detecting certain accessibility cues. One of these cues, for example, was whether a faculty member encouraged students to ask questions in class. If not, students seemed more likely to view that faculty member as being unapproachable. As one NEU student explained, "Some professors are really inviting, like they motivate you to ask them questions and they're more available. Other professors, you go to ask them a question, and they're always like, 'Yeah, just go through the lecture.'"

Generally, most of these cues regarding approachability are based largely on a faculty member's in-class behavior and demeanor. For example, another cue that focus group participants raised related to whether faculty members relied mainly on didactic versus interactive teaching methods, as those faculty who used interactive strategies tended to be perceived as more approachable. Students also pointed to a few out-of-class cues that signaled a professor's approachability. One indicator of accessibility related to how often a faculty member holds office hours, as a student from WU explained, "There's faculty office hours, but it'll maybe be an hour a week. I didn't really attend a lot of those. It's kind of hard to know if they didn't encourage interaction or if it was just

structured that way." The focus group students reported feeling little encouragement to attend office hours, and, when they did attend, students frequently complained that faculty were somewhat aloof and out of touch in terms of academic and career advising.

Perhaps faculty accessibility to undergraduates is closely coupled to the reward structure of an institution. A student at SWFU perceptively noticed this tension for her faculty member:

> She wasn't able to get any work done because she spent a lot of her time trying to help out her students, and that's why these professors might be a little bit reluctant to help with the students just because they're judged so much on how much progress they make, how many publications they get.

This pressure is likely much stronger for faculty at research-intensive institutions, which explains some of the earlier quantitative findings regarding research expenditures. Both the institution and the reward system offer few if any incentives for faculty to engage in mentoring or include undergraduates in research. A faculty director of an undergraduate research program at a WU described this challenge and discussed some alternative measures:

> It's a challenge to bring more new faculty on [to work with the program] … because there are no tenure perk points, and I've gone through that myself. It's "I've got to publish and I've got to do other things, I have to serve on this committee, I don't get any points if I [help you], so no." So one of the things we've talked about is trying to make service to the university and working with undergraduates in the program get some sort of points or somehow feel weighted so that I get more faculty [involved in the program].

Unfortunately, the lack of incentives for faculty to mentor and engage undergraduates was a recurrent theme among almost all of the staff and faculty we interviewed at the two HSIs and the two PWIs.

Faculty inaccessibility was also exacerbated by the scarcity of URM science faculty. A faculty program director at WU shared this sentiment and said, "There are very

few professors who share [students'] background, so there might be something…off-putting or intimidating about a department where they never see anyone who looks like them who made it." Conversely, this issue was not raised at SPU, the HBCU, because they have more faculty of color. It was not surprising then that students attending SPU reported that it was easier for them to identify science faculty members to serve as mentors and same-race role models.

Despite these obstacles, by the third year of college most students began to actively approach professors. One student at NEU described overcoming his initial sense of intimidation: "I didn't start reaching out until last year, and, ever since I started reaching out to professors and other groups and stuff like that, it's been very fruitful." These students also found that once they made this effort, professors took an interest in their welfare and were generally willing to assist them. For instance, students frequently noticed that faculty became more attentive once they became aware of the students' intentions to pursue a research career and/or graduate school. One student at SPU said, "If [faculty] hear you say you want to go to grad school, that's when they really start pushing and really want you to do well and really give you all the resources that you need to do well." Students were able to establish relationships with faculty by discovering simple strategies, such as clearly communicating their career goals and interest in science to faculty. After students began connecting with faculty, several seemed to find their efforts reciprocated. Through subsequent interactions with faculty, students across all institutions attested to gaining resources, encouragement, and valuable opportunities.

Ethic of Care. Students not only relied on cues to assess faculty approachability but also to determine whether a certain ethic of care existed within science departments.

For instance many students cited problems with large and impersonal class sizes and the overabundance of courses taught by unqualified teaching assistants, all of which was common for introductory science courses taken the first year of college. A SWFU student shared her experience: “You take biology, and you go into the class, and there are hundreds of students there. They’re not all going to get their questions answered by the professor. If you’re lucky, you might get the TA to answer it right, but you never know.”

Subsequently, students enrolled in the PWIs tended to describe science environments as rather uncaring due to a perceived low emphasis on teaching and a lack of opportunities for meaningful interactions with science faculty and other undergraduates. As one student from NEU shared, “From the engineering department’s viewpoint, I didn’t feel like they were supportive or they cared at all.” Similarly, regarding the lack of opportunities to interact with faculty, one student at a NEU noted, “That seems to happen when you have really good professors that are doing other things besides teaching, like doing world-renowned research. They tend to not care about the other responsibilities that come along with that.” Students’ dissatisfaction related to teaching was not an issue that affected only students at PWIs. Several students at one of the HSI campuses in our sample also remarked about problems with large class sizes and the preponderance of courses taught by TAs.

Students from only two institutions, SPU and SWFU, discussed having received personal attention from faculty. Students at both of these minority-serving institutions noted that faculty on their respective campuses tended to take a holistic approach to education by providing them with a great deal of individualized attention and by showing

concern for both their academic and non-academic lives. The following quote from a student at SWFU captures this notion of a holistic approach:

> They treat you as a whole person rather than just what you have to offer academically, and that made a big difference for me, just knowing that they're real people too, and you can go to them outside of academics, and then that in turn, the advice that they give you benefits you academically because, you know, they push in the right direction.

Comparatively, a student attending SPU shared her experience after spending a brief period at one PWI:

> I did go to [another university] for a semester and it's a big difference [at SPU] in how the teachers [interact with students]... they're more receptive of your feelings [at SPU] and what you're going through versus a big university. So that's a big difference.

Another SPU student echoed this sentiment:

> Generally HBCUs may not get as much funding, so they're not as equipped as other schools and you see that. When I went from the lab in [SPU's] classroom and then I go to [another university] and I go to the lab in their classroom, they have an incubator almost half the size of our class. At the same time, with what we have, [SPU] does give you a quality education and people tend to look over that.

Despite resource differences at some smaller minority serving institutions, such as SPU, students pointed to the ethic of care as the key feature that contributed most to the quality of their science education.

Rigor vs. Support. Another theme that emerged from our case studies was the tenuous balance between rigor and support as they relate to science curriculum and instruction. This tension was most obvious at both of our PWIs, where a vast majority of students and faculty indicated that stressful and demanding science environments were the norm. Many interviewees suggested that a major contributing factor to this stress was the "gatekeeper" courses that students often took during their first year of college. Deeply

ingrained in the culture of science at this institution was the process of weeding out students rather than providing support, as one senior administrator who oversees undergraduate research at WU explained:

> When they first come in, they really hit some barrier courses. I mean, if you're a negative person, you might call those "weeder courses," and mean that in a good way. If you're an educator, you see those as I do, as barrier courses that something needs to be done about it if possible.

These "weeder" or "barrier" courses appear to be designed around a single objective: to differentiate students' capacity for absorbing large amounts of information. Consequently many students became excessively focused on grades rather than learning, as one NEU student explained: "I think there's just an issue with academics and the grading system in general because a lot of times you're just focused on getting a good grade." The following quotes from students at NEU and WU, respectively, further illustrate this problem:

> I think for a lot of the core classes, most people approach them as, 'I just want to pass it.' Most people don't approach them as, 'This is going to be a building block that's going to help me out a lot later on when I'm going to be seeing it over and over again, so let me take this time to actually understand it.'

> It's not in your nature to learn like that I don't think. It puts too much pressure on you when you're not trying to understand the material because you like it, you're trying just to ace the class, so it's not that desire to learn, but the desire to get a better grade.

Many students described grading on a curve as a common practice in introductory science courses, which discourages "low performing" students from pursuing further coursework in the major. According to students at NEU and WU, such grading practices tend to promote rote memorization rather than deep understanding and application of knowledge.

Because the quality of pre-college preparation varies widely, those who attended lower performing high schools, for example, are at a severe disadvantage in this grading system. A faculty program director at WU explained how rigorous yet naïve standards negatively affected persistence in the major and graduate school aspirations for first-generation and underrepresented racial minority students:

> Students who don't do well in the first year have a very hard time continuing in the major… I think it disproportionately affects first-generation students who aren't prepared for it, and I think a number of underrepresented students aren't prepared for those courses either, so we try to do some intervention with students taking those courses.

This high stakes environment whereby students are forced out of science majors within the first year of college appears resistant to change as explained by the faculty program director at WU, "I think it's really tricky to talk to some professors about introducing certain kinds of supportive elements into a class," and he adds that attempts to intervene by calling attention to problems within the classroom were commonly met with stiff resistance among faculty. This point resonates with Becher's (1989) notion of academic cultures and their boundaries that inform not only teaching disciplinary knowledge but also ones' approach toward student support for learning.

The faculty at the HBCU appeared to establish a healthy balance between rigor and support. A faculty member at SPU describes this critical balance between rigor and support in SPU's instruction and curriculum:

> We're so teaching-oriented, you know. It's all about the students. You really care about the students. In every field, they put extra time into making it easy for a student and not in the sense of making the material easy. We expect them to learn, but we do help them achieve and especially in sciences.

That SPU offers a very supportive environment where learning is emphasized over grades was reinforced by a student at this institution: "I guess they're really more concerned

about you here as far as how well you do, and they always ask me, 'Well, how are you doing in your class?' If you need any extra help, they're willing to help you if you come to their office hours." Unlike the other campuses, SPU offered a distinctive culture of support, where even rigorous elements can serve to motivate aspiring science students rather than to discourage them. As one student stated, "they are always trying to take you to the next level [here]."

Conclusions

At the conclusion of our site visit, one undergraduate science major aptly captured his own sense of science identity at SPU by proudly stating that "we do science here." Such student identification with both the institution and science does not happen by chance but is nurtured through some key student experiences, including having received substantive recognition and meaningful support from faculty. As suggested by Carlone and Johnson's (2007) discussion of science identity development and Becher's (1989) insights into how that identity plays out within disciplines, institutions and faculty members can play key roles in shaping the opportunities and experiences of URM science majors. Unfortunately, the culture that students often experience as part of their science education curtails rather than advances their studies. According to Becher, these experiences include overly competitive gatekeeper lower-division science courses and an imbalance between faculty research productivity and undergraduate instruction and mentoring. Becher acknowledges that it is very difficult to change the academic culture of a discipline or department, as "any systematic questioning of the accepted disciplinary ideology will be seen as heresy and may be punished by expulsion" (p. 37). However, we found that specific campuses and patterns of faculty engagement with students can make

a significant difference in establishing a culture of support while still maintaining rigor in science training.

Our key findings from this mixed-method study point to the importance of institutional context in establishing meaningful student-faculty interaction that can facilitate students' development as scientists. Findings from the survey of first-year students suggest that both the structural characteristics of the institution as well as peer normative contexts matter in facilitating student-faculty interaction. Specifically, first-year aspiring scientists tended to report lower frequencies of interaction with faculty at institutions with larger undergraduate enrollments, more selective environments, or with faculty who treated students impersonally. Interview data confirmed that many students viewed the science classroom environment as disturbingly competitive. Program directors reported that undergraduates have difficulty with "barrier" courses and that faculty members are reluctant to introduce supportive mechanisms for learning in the classroom. Unfortunately, these problems are not unusual in science education but are instead commonly experienced by first-year students across the country. Becher (1989) argues that some of the key obstacles to improving undergraduate science education include the availability of faculty, grading practices in introductory courses, and the pressure on faculty to focus more on publishing rather than on teaching.

Overcoming these common practices, maintained by disciplinary traditions and socialization, will be an especially difficult challenge for large and selective institutions that often attract top scientific talent among faculty and students. Although findings from our cross-level analyses show that Black students at selective institutions may fare somewhat better in their level of contact with faculty, this effect is strongest for those

Black students who attend HBCUs. This finding supports prior work that shows that HBCUs tend to promote stronger connections between Black students and faculty than their PWI counterparts (Allen, 1992; Nelson Laird et al., 2007), which increases the chances of retaining first-year science students (Chang et al., 2008). Only a few students at the HSIs mentioned similar connections, and no significant effects were evident in the multi-institutional data. That there were no detectable cross-level effects for HSIs may be explained in large part by the fact that many HSIs began historically as PWIs and thus are still in the process of making institutional changes that would allow them to better serve the educational needs of their Latina/o students (Hurtado et al., 2007; Nelson Laird et al., 2007).

Even though the ways in which students are generally trained in the sciences appear to differ across institutional types, our findings also suggest that much can be done within institutions to facilitate students' progress in their science education. As noted in previous studies (Cole, 2007; Dayton, Gonzalez-Vasquez, Martinez, & Plum, 2004), students often take their initial cues from faculty in the classroom when assessing faculty approachability. Our qualitative findings confirm that students pay close attention to certain cues such as whether or not their instructor displays an ethic of caring to gauge a faculty member's accessibility.

We also identified several key opportunities that are associated with more frequent student-faculty interaction during an undergraduate student's first-year of study, which may counteract the negative effects of other contextual factors such as large size and high selectivity. These experiences include participation in academic clubs and minority support programs, as well as taking advantage of opportunities to work on a

professor's research project and to discuss course content with other students outside of class. Besides enhancing interaction with faculty, those structured research and student support programs may also help to socialize students into the culture of science at an early yet important stage in their studies. Through those experiences that occur within more intimate communities, students develop a better understanding of how to navigate their way through their major, what it means to become a scientist, and how to participate in the culture of science at their institution (Becher, 1989; Carlone & Johnson, 2007).

It is becoming increasingly clear that faculty involvement in the identification and training of developing scientists is essential to sustaining economic competitiveness and leadership in science. In order to meet the need to develop a talented and more diversified scientific workforce, policymakers and institutions can support undergraduate initiatives and faculty resources devoted to advancing the production of scientists. For example, it is important for NSF and NIH to continue to award research grants that require the training of undergraduates in ways that can produce more women and racial minority scientists. We found, for example, that first-year students who attended institutions that spent more money on research activities appear to benefit even more from working on faculty research projects. This finding suggests that research resources can play a key role in facilitating contact through the mutual goal of discovery, but, as students also indicated, faculty support also constitutes a significant resource. Allen (1992) indicated that the tradeoff between resources at a PWI and HBCU hinged on this very element of faculty support versus access to material resources, a theme that was repeated by students who were aware of these differences between institutions.

Likewise, those faculty and program administrators whom we interviewed emphasized the difficulty they had with balancing the demands of academia and the needs of their programs and students. Several program administrators who have faculty appointments also indicated a difficulty in recruiting new faculty mentors for their respective undergraduate research programs because of the lack of tangible institutional incentives and rewards. One way to reverse this trend is for institutions to reward faculty involvement with undergraduate research and academic support initiatives when considering tenure and promotion, which would also signal a stronger commitment to students and place a higher priority on faculty accessibility and support.

Another important implication from our research concerns institutional norms and how some practices tend to derail more than advance students' progress and interest in pursuing scientific inquiry. It appears most institutions can benefit from actively reshaping their culture of science on campus to more effectively balance rigor and support in ways that better acquaint students with the empowering and collaborative side of scientific discovery (Hurtado et al., 2007). Based on our findings, it also seems prudent for institutions to promote innovations for teaching and learning that engage students in science and minimize the widespread perception among first-year students that the science environment tends to be impersonal and sterile. Although this study further establishes the importance of intentionally shaping the unique context in which undergraduate science education takes place, especially with respect to facilitating higher levels of student-faculty interaction, the next phase of our work will focus more centrally on how intervention strategies can be scaled-up from the program to the institutional level to increase the production of young scientists from diverse populations.

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Table 1
Description of Variables and Measures

Variable	Coding
Dependent Variable	
Faculty interactions	Factor composed of four variables relating to the frequency of: interacting with faculty outside of class (0.62), interacting with faculty during office hours (0.60), receiving advice from faculty about the educational program (0.60), and receiving emotional support from faculty (0.59); (alpha = 0.68)
Individual Characteristics (Level 1)	
Background Characteristics	
Sex: Female	0=male, 1= female
Race: Latino	0=no, 1=yes (referent White)
Race: Black	0=no, 1=yes (referent White)
Race: Asian	0=no, 1=yes (referent White)
Race: American Indian	0=no, 1=yes (referent White)
Father's education	1=grammar school or less to 8=graduate degree
Mother's education	1=grammar school or less to 8=graduate degree
Parental income	1=less than $10,000 to 14=$250,000 or more
Pre-College Experiences	
High school GPA	1=D to 8=A or A+
Felt bored in class in high school	1=not at all to 3=frequently
Asked teacher for advice after class in high school	1=not at all to 3=frequently
Participated in pre-college summer research program	0=no, 1=yes
Science domain identification in 2004	Factor composed of four variables relating to the goals of: obtaining recognition from colleagues (0.71), making a theoretical contribution to science (0.62), becoming and authority in my own field (0.59), and working to find a cure for a health problem (0.55), (alpha = 0.71)
College Experiences	
Studied with other students in college	1=not at all to 3=frequently
Felt overwhelmed in college	1=not at all to 3=frequently
Felt intimidated by faculty	1=not at all to 4=frequently
Family responsibilities interfered with academics	1=not at all to 4=frequently
Faculty here are interested in students' personal problems	1=strongly disagree to 4=strongly agree
Students here are treated like numbers in a book	1=strongly disagree to 4=strongly agree
Faculty here are interested in students' academic problems	1=strongly disagree to 4=strongly agree
Participated in first-year seminar course	0=no, 1=yes
Participated in pre-professional or departmental club	0=no, 1=yes
Participated in an academic enrichment program for minority students	0=no, 1=yes
Discussed course content with students outside class	1=not at all to 4=frequently
Worked on a professor's research project	1=not at all to 4=frequently

Received negative feedback about academic work	1=not at all to 4=frequently
Studied	1=none to 9=over 30 hours/week
Cumulative GPA at the end of the first year of college	1=C- or less to 6=A
Success at managing the academic environment	Factor composed of five variables assessing students' success at: understanding professors' academic expectations, developing effective study skills, adjusting to academic demands of college, managing time effectively, and getting to know faculty. (alpha = 0.78)
Sense of belonging	Factor composed of three variables assessing students' agreement with the statements: I see myself as a part of the campus community, I feel I am a member of this college, and I have a sense of belonging to this college. (alpha = 0.84)
Positive cross-racial interactions	A factor with seven variables assessing how often students have experienced the following with students from a different racial/ethnic group from their own: socialized, dined/shared a meal, had meaningful and honest discussions about race/ethnicity, shared personal feelings and problems, had intellectual discussions outside of clas, studied or prepared for clas, socialized or partied. (alpha = 0.90)
Institutional Contexts (Level 2)	
Control: Private	0=no, 1=yes
Offer research experiences to first-year students	0=no, 1=yes
Institutional selectivity	Continuous; range 400-1600, rescaled to 4-16
Undergraduate FTE enrollment	Continuous; natural log of total undergraduate FTE enrollment
Proportion of undergraduate students majoring in biomedical and behavioral sciences	Continuous
Average science domain identification of students entering college in 2004	Average of science domain identification (level-1 variable) for each institution
Average opinion: Students here are treated like numbers in a book	Average of this opinion variable (level-1) for each institution
HBCU	0=no, 1=yes
Research expenditures	Continuous; natural log of research expenditures

Note: Authors will provide means, standard deviations and correlations upon request.

Table 2
Site Visit Institutional Profiles

Pseudonym	Southern State University (SSU)	Southwestern Flagship University (SWFU)	Southern Private University (SPU)	Western University (WU)	North East University (NEU)
Size	20,000	15,000	5,000	20,000	5,000
Control	Public	Public	Private	Public	Private
Type	HSI	HSI	HBCU	PWI	PWI
Selectivity (Admittance Rate)	90%	70%	60%	50%	20%
Ethnic Enrollment	44% Latino 39% White 8% Black 6% Asian	47% White 34% Latino 4% Asian 3% Black 6% American Indian	75% Black 8% Asian 2% White 1% Latino	46% Asian 28% White 12% Latino 1% Black	37% White 26% Asian 12% Latino 7% Black 1% American Indian

Table 3
Results of HLM Analyses Predicting Student-Faculty Interaction Among Science Students

	Coef.	S.E.	Sig.
Level 1			
Background Characteristics			
Sex: Female	-0.09	0.10	
Race: Latino	-0.19	0.13	
Race: Black	-0.79	0.33	*
Cross-level interaction: HBCU	0.62	0.17	***
Cross-level interaction: Institutional selectivity	0.35	0.11	**
Cross-level interaction: Undergraduate FTE enrollment	0.33	0.14	*
Race: Asian	-0.22	0.11	*
Race: American Indian	0.51	0.28	
Father's education	0.04	0.02	
Mother's education	-0.01	0.03	
Parental income	-0.02	0.02	
Pre-College Experiences			
High school GPA	-0.01	0.04	
Felt bored in class in high school	-0.18	0.07	**
Asked teacher for advice after class in high school	0.31	0.06	***
Participated in pre-college summer research program	0.23	0.15	
Science domain identification in 2004	0.07	0.02	***
College Experiences			
Studied with other students in college	0.38	0.07	***
Felt overwhelmed in college	0.10	0.07	
Felt intimidated by faculty	0.04	0.05	
Family responsibilities interfered with academics	0.17	0.05	**
Faculty here are interested in students' personal problems	0.48	0.06	***
Students here are treated like numbers in a book	-0.10	0.07	
Faculty here are interested in students' academic problems	0.20	0.08	*
Participated in first-year seminar course	0.13	0.08	
Participated in pre-professional or departmental club	0.46	0.12	***
Cross-level interaction: Research expenditures	-0.02	0.01	*
Cross-level interaction: Average science domain identification	0.38	0.22	
Cross-level interaction: Average opinion: Students are treated like numbers in a book	0.55	0.27	*
Participated in an academic enrichment program for minority students	0.30	0.09	**
Discussed course content with students outside class	0.29	0.07	***
Worked on a professor's research project	0.22	0.05	***
Cross-level interaction: Research expenditures	0.02	0.01	*

Received negative feedback about academic work	0.25	0.05	***
Studied	0.10	0.03	***
Cumulative GPA at the end of the first year of college	-0.14	0.04	***
Success at managing the academic environment	0.79	0.11	***
Sense of belonging	-0.18	0.09	*
Positive cross-racial interactions	0.21	0.05	***
Level 2			
Intercept	5.50	0.70	
Control: Private	0.13	0.14	
Offer research experiences to first-year students	0.14	0.11	
Institutional selectivity	-0.47	0.13	**
Undergraduate FTE enrollment	-0.74	0.18	***
Proportion of undergraduate students majoring in biomedical and behavi	-0.01	0.00	*
Average science domain identification of students entering college in 200	-0.57	0.32	
Average opinion: Students here are treated like numbers in a book	-0.89	0.35	**

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: HLM analysis of 2004 Freshman Survey and 2005 Your First College Year data.