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Making a Difference for Minorities: Evaluation of an Educational Enrichment Program

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Abstract: A comprehensive, quantitative evaluation of an educational intervention program designed to reduce the attrition of minorities from the biological sciences was undertaken to ascertain whether such efforts adequately address the problem. Program participants had greater odds of persisting in basic math and science courses, and of graduating in biology, than did a comparison group, controlling for demographics and academic preparation. Undergraduate research greatly increased the odds of positive graduation outcomes. Program participants were also more likely to pursue graduate study than were university graduates overall. This evaluation demonstrates the value of such programs in increasing the representation of minorities in science. © 2004 Wiley Periodicals, Inc. *J Res Sci Teach* 00: 1–21, 2004

Despite recent demographic shifts increasing the proportion of minority groups in the U.S. population, substantial differences in educational attainment continue to perpetuate racial and ethnic occupational segregation in the labor force. This is particularly acute for science occupations. Although underrepresented minorities (African Americans, Native Americans, and Hispanics) comprised 24% of the working-age population in 1999, they formed only 7% of the science and engineering workforce in that year (National Science Foundation [NSF], 2000). Minority students are less likely than Whites and Asian Americans to complete high school and attend college, are less likely to complete a bachelors degree, and are hence less likely to pursue an advanced degree (NSF, 2000). Minority students entering college are at least as likely as White students to intend to pursue a science degree (NSF, 2002b), yet they are less likely to graduate in

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their intended major. Only 27% of the Hispanic, African American, and Native American students who began college in 1989 intending to major in science or engineering graduated with a baccalaureate degree in one of those fields by 1994, compared with 46% of White and Asian students (Huang, Taddese, & Walter, 2000).¹

The problem of underrepresentation becomes more extreme at higher levels of educational attainment. Although underrepresented minority students earned 15.7% of bachelors degrees in science and engineering in 2000, they earned a diminishing proportion of the advanced degrees in those fields: 8.8% of masters degrees and 5.9% of doctoral degrees (NSF, 2002a). Such disproportionate attrition has prompted a proliferation of special services and programs attempting to plug the leak in what has become known as the science “pipeline.” The approaches of these programs vary widely, some focusing solely on academic course work, some emphasizing research experience, and others providing reinforcements at the level of advising and self-esteem. However, few rigorous, quantitative evaluations of these programs have been widely disseminated (Gandara & Maxwell-Jolly, 1999). This article attempts to fill this research void by presenting evaluation results of an educational enrichment program, the Biology Undergraduate Scholars Program (BUSP), at the University of California, Davis (UCD).

BUSP was established in 1988 to address significant university-wide racial/ethnic disparities in graduation in the biological sciences.² A campus study of the achievement gap during the mid-1980s found that although 11% of freshman biology majors were from minority groups, the proportion of underrepresented minority students decreased to 7% by graduation; a 36% greater attrition than that of majority group students (Villarejo & Tafoya, 1995). Among this small pool of minority biology graduates, relatively few were good candidates for graduate or professional school: the fraction of minority graduates with cumulative GPAs of B (≥ 3.0) was about one half that of White graduates (Villarejo & Tafoya, 1995).

To address this problem, the design of BUSP drew on the research literature on minority academic achievement and borrowed aspects of two pioneering programs for minority students, resulting in a program that addresses attrition from science majors through pedagogical and structural strategies. The calculus workshops at University of California at Berkeley address the fact that many underrepresented minority college students enter college less prepared in mathematics and science than majority students (Vetter, 1994; Schneider, 2000). The preparation differences are particularly extreme in mathematics: while approximately 6% of African American, Native American, and Hispanic 1998 high school graduates had taken calculus, twice as many Whites and three times as many Asian/Pacific Islanders had done so (NSF, 2002c). These deficits, in turn, decrease the likelihood of persisting in math and science majors. The Berkeley calculus workshops, initiated by Uri Treisman (Fullilove & Treisman, 1990), use challenging course work, coupled with a cooperative approach to problem solving, to promote minority student achievement. At Xavier University (Carmichael, Labat, Huter, Privett, & Sevenair, 1993), the Stress On Analytical Reasoning (SOAR) program elicited student success through a highly structured and enriched curriculum supported by a strong tutoring and advising system. (Academic and career advising, as performed in the SOAR program and many others, is also a central part of BUSP, although its efficacy remains unexplored in this article.)

Underrepresented minority students are also less likely than majority students to possess the financial resources necessary to complete college unencumbered by excessive work schedules and large loans. The study found that 66% of Hispanics, 76% of African Americans, and 81% of Native Americans borrowed funds to complete their bachelors degrees in 1997 and 1998, compared with 59% of Whites and 56% of Asians (NSF, 2002d). Astin (1982) found that financial aid in the form of grants, rather than loans, are strongly associated with student persistence to graduation. Work-study programs in which students work on-campus less than 20 hours per week were particularly

effective in facilitating student persistence, while working off-campus or more than 20 hours per week was associated with decreased likelihood of graduation.

Finally, the research literature also suggests that underrepresented minority students may become socially isolated (Wilson, 2000) and that strong peer networks help reduce this isolation and provide academic support. Astin and Astin (1992) found that a strong peer group orientation is associated with increased persistence among science majors.

In response to these concerns, BUSP attempts to foster academic success by providing academic, financial, and support services through the freshman and sophomore years at the university. Specifically, it provides supplemental academic instruction in General Chemistry, Calculus, and Introductory Biology; academic and personal advising; and practical experience and financial support through employment in research laboratories. It also attempts to develop strong peer networks through the small size of the program, the intensive nature of the supplemental instruction, and the use of facilitated study groups.

BUSP requires students to attend a series of supplemental workshops for the crucial “gatekeeper” courses. Workshops begin with a quarter-long Pre-Chemistry course prior to enrolling in General Chemistry, plus 2 hours per week of chemistry workshops to supplement General Chemistry instruction. BUSP students were also required to attend supplementary Calculus workshops for 2 hours per week. The Pre-Chemistry course and supplementary workshops were small, with no more than 25 students per class, and emphasized problem solving and group work. Comparison Group students did not have access to supplementary chemistry instruction, but could choose to participate in the calculus workshops if they wished.

Participation in laboratory research is a major part of the BUSP design, but is not mandatory. During the period under study, students were encouraged to begin working in a research laboratory as soon as possible, frequently in the freshman year. Responses to surveys and interviews have suggested that the opportunity to work in a research laboratory was a significant draw for students opting to participate in the program. As a result, 70% of BUSP students chose to work in a laboratory for at least one term. Faculty mentors were asked to provide a developmental experience for the students, that is, to introduce beginning students to the laboratory environment by starting with simple laboratory tasks, advancing to more challenging activities as students demonstrate competence at each level. Research participation has long been held to increase the probability of students persisting in science majors, but very little research has investigated the issue. In a rare empirical study of the impact of research participation on persistence in science majors, Astin and Astin (1992) found a consistent association between participating in a professor’s research project and persistence in—or recruitment into—a science major.

The BUSP model, including academic enrichment, advising, and research experience, is a costly investment of faculty and staff time, and institutional and foundation [funds](#)^{Q2}. To determine whether this investment is justified, this study asks whether BUSP participation made a difference in the academic performance and graduation outcomes of the 397 students who entered BUSP during the period 1988–1994. This article examines only the quantifiable aspects of the program, with more qualitative indicators to be examined later. First, we ask whether program participation increased persistence and performance in basic math and science courses; and examine the effect of supplemental workshops on course performance. We then measure the impact of overall program participation on graduation outcomes, and ask whether participation in laboratory research improved graduation rates. These analyses are performed using multivariate analysis, controlling for demographic attributes and academic preparation. Finally, to determine the enduring effects of the program on the science pipeline, we look at student postgraduation educational and career activities.

Method

Participants

All admitted underrepresented minority freshmen with an interest in majoring in the biological sciences were eligible to join BUSP. Students received a solicitation to join the program after being admitted to the campus. Each year, 150–200 new students were invited to participate in the program, and 50–61 students, or about one third of the eligible pool, elected to participate. These 397 program participants (the BUSP group) are compared with the 877 students who opted not to participate in the program (the Comparison Group).

BUSP students who entered UCD 1988–1994 came from a wide range of academic and ethnic backgrounds. Two-thirds were female, 56% were Hispanic, 26% were African American, 5% were Native American, and 13% were Asian American (Table 1). In the program’s first year, 1988, 36% of BUSP entrants were admitted by Special Action, the admissions category reserved for those who do not meet minimum requirements for university admission,³ but who are nonetheless considered to have the potential for academic success. Students admitted by Special Action are far less likely to graduate from UCD than are regularly admitted students (over the decade 1983–1992, 82% of regularly admitted students overall graduated from UCD, compared with only 58% of Special Action admits) (Student Affairs Research & Information, 1999). Notably, each successive BUSP class has been better prepared academically than the preceding class. By 1994, the portion of the entering class admitted by Special Action had declined to 24%.

The overwhelming majority of BUSP participants enter college intending to pursue health-related careers. Survey responses ($N = 70$) suggest that approximately 90% of incoming program participants intend to pursue health-related careers; seventy percent ($n = 49$) hoped to become

Table 1
Population characteristics by group

Characteristic	BUSP		Comparison Group	
	<i>n</i>	%	<i>n</i>	%
Demographic characteristics				
Female	263	66	578	66
African American	103	26	160	18
Native American	19	5	50	5
Mexican American	150	38	262	30
Other Latino(a)	69	18	156	18
Asian American ^a	52	13	248	28
Other	2	<1	1	<1
Total	397	100	877	100
Academic preparation				
High school GPA ^b	3.42		3.58	
Mean math SAT	498		523	
Mean verbal SAT	418		458	
Special action admissions	30%		14%	

^a91.7% of this group were Filipino, 2.3% Chinese American, less than 1% Korean and Indian, and 5.0% Other Asian. In 1988, Filipino students were underrepresented at the University of California, based on their proportion of the state population. Other Asian participants were economically and/or educationally disadvantaged.

^bHigh school grade point average (GPA) was calculated using only the academic courses (A–F requirements) taken in the 10th and 11th grades; with honors and AP credits capped at 8 semesters.

physicians, while another 9% had planned to become dentists or veterinarians. While students vary in their motivations for their interest in health-related careers, many respondents were attracted to these professions because they enjoy working with people (26%), they wanted to help people and/or their community (25%), and because they enjoy science (16%).

The Comparison Group had the same sex ratio as the BUSP group, but disproportionately fewer African American and Mexican American students. Comparison Group students were, on average, better prepared academically than students who elected to participate in BUSP. Comparison Group students had higher high school GPAs, higher mean math SATs, and much higher mean verbal SATs, and the Comparison Group had one half as many Special Action students as BUSP (Table 1)—all indicators that they would fare better in college than the BUSP group. The lower verbal SAT scores of the BUSP students may be explained by their greater linguistic heterogeneity: many did not have spoken English as their first language. 1993 and 1994 admissions data show that BUSP students were less likely than their Comparison Group counterparts to have English as a first language: 28% of BUSP students reported a non-English language as a first language, compared with 17% of the Comparison Group.

Both BUSP and Comparison Group students had lower levels of high school preparation than the 1988–1994 UCD freshman entering classes as a whole. The mean average freshman verbal SAT I score for those years was 487, the mean average math SAT I was 577, and the mean average high school GPA was 3.64 (Student Affairs Research & Information, 1995).

Design and Procedure

Multivariate statistical analyses are the primary tool by which we examine the efficacy of BUSP. Specifically, multivariate linear and logistic regression models are used to estimate the impact of supplemental workshops, research experiences, and overall program participation on persistence and performance in basic math and science courses and graduation outcomes. Data on the long-term effects of program participation do not lend themselves to multivariate analysis, and hence are characterized using descriptive statistics

Data Files and Variables

The names of all students who had been invited to apply to the program from 1988 to 1994 were submitted to UCD's Student Affairs Research & Information (SARI) office. These were divided into BUSP participants and nonparticipants. Students who initially joined the program but attended supplemental courses for less than one term were excluded from the analysis. SARI personnel then used university records to develop a main data file.

The main data file included variables postulated to be associated with academic performance and graduation outcomes, which were used as controls in the statistical models.⁴ These controls include sex, race/ethnicity, math and verbal SAT I scores, high school GPA, and admissions status (see Appendix A for complete list of data file variables). Because analyses of the impacts of supplemental workshops and research experience are performed for BUSP participants only, their records were copied into separate data files and augmented with data pulled from BUSP and university records. Thus, in addition to data from the main file, the supplemental workshop data file also contained the course number of the workshop, term and year of workshop enrollment, and workshop grade for each BUSP participant. The research experience data file included the term and year of each research placement, and research mentor's name for each BUSP participant (see Appendix A for the complete list of variables in each file).

Recodes

All data were received as text files and were imported into SPSS for Windows version 8.0.2. Nominal data were translated from alphanumeric format to coded numeric format. Preliminary analyses indicated that the main ethnic group differences in academic outcome were between Asian and non-Asian students; thus race/ethnicity was recoded as a dummy variable in which 1 = Asian ethnicity and 0 = non-Asian ethnicity. Verbal and math SAT I scores were recoded in 50-point increments, since earlier analyses indicated that they were strongly correlated with other academic preparation measures and therefore could pose coefficient estimation problems if the variables were not transformed. For the same reason, high school GPA was recoded into quarter-point increments.

Statistical Analysis

The contribution of supplemental workshops, research experience, and overall program participation on academic performance and graduation outcomes are estimated using linear and logistic regression models, while the long-term effects of program participation are characterized using descriptive statistics. Both linear and logistic regression models control for differences in academic preparation and ascribed characteristics. All BUSP group-only models employ an identical set of control variables. These are: program participation, Asian ethnicity, sex, high school GPA, math SAT I score, and verbal SAT I score.

Models that compare BUSP with the Comparison Group also include the variable Admissions Status. Admissions status refers to whether the student was admitted via “Special Action” or “Regular” procedures. As described above, students admitted by Special Action do not meet standard university admission criteria, but are considered to have other merits that warrant entry; they also graduate at significantly lower rates than regularly admitted students (Student Affairs Research & Information, 1999). Admissions status is excluded from all BUSP-only analyses because the variable is too highly correlated to transformed and nontransformed academic preparation measures to produce reliable coefficient estimates for these models.

Persistence and Performance in Basic Science and Math Courses. BUSP and Comparison Groups are compared for their persistence and performance in the basic “gatekeeper” courses: General Chemistry, Calculus, and Introductory Biology. Multivariate logistic models are used to predict the effects that program participation had on the odds of persisting through the course sequence in each of the three subjects. Persistence through a course sequence is defined as progressing through an entire course sequence with a nonfailing grade ($\text{GPA} \geq 1.0$). Those who never initiated a course series are excluded from the denominator. Multivariate linear regression models are used to predict the effect of program participation on the course GPAs of students who persisted through a course sequence.

Impact of Supplemental Workshops in General Chemistry and Calculus. To determine the impact of specific supplemental workshops on related course performance, BUSP group-only data were used in linear regression models. Although all BUSP students were required to enroll in the workshops, some received failing grades in the supplementary workshops that accompanied Calculus and General Chemistry, indicating that they had not attended class regularly and/or did not complete homework assignments. Sufficient numbers of students enrolled in General Chemistry 2A and 2B and Calculus 16A and 16B to enable analysis of the impact of the respective

supplementary workshops on GPAs in each of these courses. Passing or failing the supplemental workshop is the independent variable for these models.

Effects of Program Participation on Graduation Outcomes. We next questioned whether the positive influences of program participation observed in the early undergraduate career endure to graduation. Three graduation outcomes were considered relevant. Graduation from UCD in any major measures persistence; graduation from UCD in a biology major (see Appendix B for the full list of majors included under the rubric of biology) indicates persistence in science, and graduation from UCD in a biology major with a ≥ 3.0 cumulative GPA shows that students meet the minimum requirements for candidacy to graduate or professional school. These three graduation outcomes are the dependent variables for logistic regression models comparing BUSP participants with Comparison Group students, controlling for academic preparation and demographic differences. We use the same set of variables as for the other comparative group models.

Graduation rates are calculated for students entering UCD 1988–1994 who graduated from UCD by June 2000. This results in a minimum 6-year graduation rate (for 1994 entrants), and a maximum 12-year graduation rate (for 1988 entrants). Prior analysis has found that after six years, increase in graduation rates is negligible.⁵ These data represent minimum college graduation rates, as some students have transferred and completed undergraduate degrees at other institutions.

Impact of Research Participation on Graduation Outcomes. Does research participation, a voluntary component of BUSP, influence graduation outcomes? Intra-(BUSP) group logistic regression models on each of the three graduation outcomes (graduation from UCD in any major, graduation in a biology major, graduation in a biology major with a ≥ 3.0 cumulative GPA) are used to investigate this issue. Control variables included in the model are identical to those in all the BUSP-only models. We then address the issue of motivational selectivity between researcher and non-researcher groups by including Pre-Chemistry workshop grade as a proxy for motivation.

Postgraduate Activities. Finally, we compare the post-UCD activities of program participants to UCD graduates overall. Data collected through BUSP alumni and graduate surveys and personal communications ($N = 172$) are compared with the published results of a UCD survey of June 1999 graduates conducted 1 year after graduation ([Student Affairs Research & Information, 2001](#)^{Q3}), $N = 1106$. The activities of BUSP participants are compared with the surveyed UCD graduates using categorical percentages.

Results

Persistence and Performance in Lower-Division Science and Math

To test the value of supplemental instruction, we first compared BUSP and Comparison Group students on their persistence and performance in foundation science classes. The raw data show that BUSP students are more likely to successfully complete the three-quarter sequences in General Chemistry and Calculus than students in the better-qualified Comparison Group (Table 2). Students who complete the full 1-year course sequence are termed “persisters.” Additionally, the mean grade point average (GPA) of BUSP students who persisted in General Chemistry was substantially higher than the mean GPA of the Comparison Group, suggesting the effectiveness of supplementary instruction in chemistry. In Calculus, more BUSP students

Table 2
Persistence and performance in basic math and science courses by group

Course	BUSP				Comparison Group			
	<i>n</i>	%	Mean GPA	SD	<i>n</i>	%	Mean GPA	SD
General chemistry	285	72	2.78	0.66	493	56	2.47	0.62
Calculus	242	61	2.67	0.70	457	52	2.64	0.68
Introductory biology	204	51	2.46	0.69	422	48	2.57	0.70

Note. Mean GPAs and associated SDs are calculated for persisters only.

persisted, but their mean GPA was essentially the same as that of the Comparison Group (Table 2). Two quarters of General Chemistry are prerequisite to the Introductory Biology series. Of the original 397 BUSP students, one half persisted through the basic science courses to the end of the Introductory Biology series, similar to the persistence of the Comparison Group (Table 2). However, the BUSP students did not have a grade advantage in the Introductory Biology series.

These data may be translated into odds ratios,⁶ which express the factor by which BUSP students were more or less likely than their counterparts to persist through the year-long course series. The odds of an event, *e*, equal the ratio of the probability of the event to the probability that the event won't occur, or odds (*e*) = probability (*e*)/(1 – probability (*e*)). For example, using the probabilities of persistence in basic science and math courses from Table 2, the observed odds of BUSP students completing the chemistry series are .72/(1 – .72) or 2.57, while the observed odds of Comparison Group students completing the chemistry series are 1.27. The observed odds ratio of BUSP to the Comparison Group is therefore 2.57/1.27, or 2.02. That is, BUSP students have twice the odds of completing the General Chemistry sequence as students in the Comparison Group. Using the same method to calculate the observed odds ratio for persistence in Calculus indicates that BUSP students' odds of persisting in Calculus exceeded that of the Comparison Group by a factor of 1.44, or 44%, despite the 25-point advantage to the Comparison Group in mean math SAT scores (Table 1).

Such direct comparison of the two groups is of limited value due to differences in academic preparation and demographic characteristics. To “correct” statistically for these differences, it is necessary to use multivariate statistical modeling. Logistic regression is one such multivariate method: it predicts the impact that a change in an independent variable (e.g., program participation) has on the odds of being in a particular category of a nominal dependent variable (e.g., graduation in biology) while holding demographic and academic preparation variables constant. This procedure leads to a predicted odds ratio that is “adjusted” for these differences, and is thus interpreted as the increase (or decrease) in the odds of the outcome due to the independent variable, controlling for all the other variables in the model.⁷ The models therefore describe the efficacy of the program, controlling for the other variables, and indicate which variables in the equation have the greatest impact on academic outcomes. All models presented here use demographic and academic preparation characteristics as independent variables.

The predicted odds ratios, and extremely low *p*-values, indicate that program participation was a significant factor associated with a greatly increased odds of completing the lower division science courses prerequisite to graduation in a biology major (Table 3). Controlling for the demographic and academic preparation characteristics in the model, BUSP students had 3-fold greater odds of completing General Chemistry, 2-fold greater odds of completing Calculus, and 1.7-fold greater odds of finishing Introductory Biology than did students in the Comparison

Table 3

Effects of program participation, demographic characteristics, and academic preparation on persistence in basic math and science courses: logistic regression results (n = 1,213)

Variable	General Chemistry ^a			Calculus ^b			Introductory Biology ^c		
	B	SE B	Odds Ratio	B	SE B	Odds Ratio	B	SE B	Odds Ratio
Program participation	1.13	0.15	3.09**	0.77	0.15	2.16**	0.50	0.14	1.65**
Asian ethnicity ^d	0.59	0.17	1.80**	0.66	0.16	1.94**	0.39	0.15	1.48**
Female	0.01	0.14	1.01	-0.12	0.14	0.88	-0.05	0.13	0.95
High school GPA ^e	0.27	0.05	1.31**	0.28	0.05	1.32**	0.26	0.05	1.29**
Math SAT ^f	0.23	0.04	1.26**	0.35	0.05	1.42**	0.15	0.04	1.16**
Verbal SAT ^f	-0.04	0.04	0.96	-0.13	0.04	0.88**	0.08	0.04	1.09*
Admissions status	-0.19	0.20	0.83	-0.26	0.20	0.77	0.07	0.19	1.07

^a $\chi^2(7, N = 1213) = 193.98, p < .01$.

^b $\chi^2(7, N = 1213) = 238.33, p < .01$.

^c $\chi^2(7, N = 1213) = 138.08, p < .01$.

^dAsian ethnicity is the reference category, and consists primarily of Filipinos, who at that time had been considered an underrepresented minority. Other Asians (excluding Pacific Islanders) are not considered to be underrepresented minorities according to University of California policy.

^eMeasured in quarter-point increments. Calculated using only the academic courses (A–F requirements) taken in the 10th and 11th grades, with honors and AP credits capped at 8 semesters.

^fMeasured in 50-point increments.

* $p < .05$; ** $p < .01$.

Group. In fact, the BUSP group's lower GPA in Introductory Biology, observed above, is directly associated with their greater persistence in that course (data not shown).

Not surprisingly, academic preparation in high school is also associated with persistence in basic science classes. Table 3 shows that a quarter-point increase in high school GPA confers a similar advantage in the odds of completing each of the introductory science series as a 50-point increase in Math SAT. Verbal SAT scores show an ambivalent association with improved performance in lower division science courses. Although each 50-point increase in verbal SAT is associated with a 9% increase in the odds of persisting in Introductory Biology, the same increase in verbal SAT is associated with a surprising 12% reduction in the odds of persisting in Calculus. Lastly, Asian ethnicity was also found to be associated with persistence in introductory science and math courses. This statistical association was found for each of the three course series: the magnitude of the effect for persistence in Calculus and Introductory Biology was nearly as great as the effect of participating in BUSP (for more on the greater persistence of Asian students in SME majors, see, e.g., Astin & Astin, 1992).

Controlling for the other variables in the model, BUSP participation confers roughly the same advantage on persistence in General Chemistry as that conferred by a half-point increase in high school GPA or a 100-point increase in math SAT. The effect of BUSP participation on persistence in Calculus and Introductory Biology is somewhat less, but nonetheless confers a greater advantage than a 50-point increase in math SAT score. The data presented in Table 3 demonstrate that the quality of academic preparation in high school, as reflected in high school GPA and SAT I scores, is strongly associated with student persistence in lower division science classes, but that a program of academic enrichment and personal support in the early college years can partly compensate for poor high school preparation.

Effects of Supplemental Workshops on Course Performance: BUSP Students Only

BUSP students are more likely than the Comparison Group to persist in basic math and science courses, and they also earn higher calculus and chemistry GPAs, but is this attributable to supplemental course work? To isolate this variable, we capitalize on the fact that not all students took full advantage of the opportunity for additional instruction. Although all BUSP students were required to enroll, some received failing grades in the supplementary workshops that accompanied Calculus and General Chemistry, indicating that they had not attended class regularly and/or did not complete homework assignments. Separate linear regression models quantify the effect of participation in supplementary course work by measuring achievement in two terms (terms A and B) of General Chemistry and Calculus for students who received a passing grade in the supplementary workshop compared with those who did not.

A strong statistical association is observed between workshop participation and Calculus and General Chemistry GPA (Table 4). A passing grade in the Chemistry A workshop was associated with a .76-point increase in Chemistry A GPA, while the Chemistry B workshop

Table 4
Effects of supplemental instruction, demographic characteristics, and academic preparation on performance in general chemistry and calculus: linear regression results

Variable	General Chemistry GPA					
	A ^a			B ^b		
	<i>B</i>	SE <i>B</i>	β	<i>B</i>	SE <i>B</i>	β
Supplemental instruction	0.76	0.17	.31**	0.69	0.12	.39**
Asian ethnicity ^c	0.09	0.14	.05	0.05	0.13	.03
Female	−0.20	0.11	−.13	−0.27	0.11	−.17*
High school GPA ^f	0.08	0.03	.17*	0.07	0.03	.15*
Verbal SAT ^g	0.02	0.03	.06	0.05	0.03	.12
Math SAT ^g	0.10	0.03	.25**	0.13	0.03	.31**
Variable	Calculus GPA					
	A ^c			B ^d		
	<i>B</i>	SE <i>B</i>	β	<i>B</i>	SE <i>B</i>	β
Supplemental instruction	0.77	0.33	.17*	0.79	0.30	.21**
Asian ethnicity ^c	0.30	0.18	.13	−0.08	0.22	−.03
Female	−0.10	0.15	−.05	0.04	0.17	.02
High school GPA ^f	0.10	0.05	.17*	0.17	0.06	.24**
Verbal SAT ^g	−0.02	0.04	−.03	−0.08	0.05	−.15
Math SAT ^g	0.13	0.05	.27**	0.20	0.06	.35**

Note. ^a $R^2 = .28$; $F(6, 158) = 9.90$, $p < .01$.

^b $R^2 = .39$; $F(6, 150) = 15.50$, $p < .01$.

^c $R^2 = .18$; $F(6, 160) = 5.57$, $p < .01$.

^d $R^2 = .21$; $F(6, 148) = 6.25$, $p < .01$.

^eAsian ethnicity is the reference category, and consists primarily of Filipinos, who at that time had been considered an underrepresented minority. Other Asians (excluding Pacific Islanders) are not considered to be underrepresented minorities according to University of California policy.

^fMeasured in quarter-point increments, and calculated using only the academic courses (A–F requirements) taken in the 10th and 11th grades; with honors and AP credits capped at 8 semesters.

^gMeasured in 50-point increments.

* $p < .05$; ** $p < .01$.

was associated with .69-point increase in Chemistry B GPA. Passing the Math A workshop was associated with a .77-point increase in Math A GPA; participation in the Math B workshop was associated with a .79-point increase in Math B GPA. These results are similar to those found for underrepresented students participating in a calculus workshop at California Polytechnic University (Bonsangue & Drew, 1995).

Lastly, although sex is not statistically associated with Calculus performance in these models, it is associated with performance in the latter term of General Chemistry, with females earning GPAs in this course that were more than a quarter-point lower than their male counterparts, controlling for demographic and academic preparation variables and Co-Chemistry attendance.

Association of Program Participation With Graduation Outcomes

Does the influence of program participation and high school academic preparation that we see in the lower division basic science classes persist until graduation? To answer that question, the graduation outcomes for BUSP students are compared with those of the Comparison Group (Table 5). Looking at the raw data in Table 5, BUSP and Comparison Group students appear comparable at the lower levels of academic achievement: the two groups had the same UCD graduation rate, and the same proportions graduated with a major in biology. However, at the higher levels of academic achievement, BUSP students trailed behind those in the other group. Only 12% of BUSP students graduated in biology with a ≥ 3.0 GPA, while 15% of the Comparison Group did so.

To adjust for the differences between the groups, we have again used logistic regression modeling to identify the factors associated with student success. Participation in BUSP was associated with an almost 50% increase in the odds of graduating with a degree in biology, demonstrating the positive association of program participation with persistence in science (Table 6). In contrast, the data did not link program participation to attaining a GPA ≥ 3.0 at graduation for biology majors (Table 6). However, linear regression analysis indicates that BUSP participation is associated with a rise in graduates' cumulative GPA, but not quite enough to get a substantial fraction above the 3.0 grade-point threshold. (Cumulative GPA model for graduates in any major: $F(7, 852) = 66.63, p < .01$ for the main effect; $R^2 = .356$. The effect of program participation is significant at $p = .03$; $B = .06$; $\beta = .06$. Cumulative GPA model for biology graduates: $F(7, 425) = 31.07, p < .01$; $R^2 = .343$. The effect of program participation is significant at $p < .01$; $B = .11$; $\beta = .12$.)

The single most important predictor of student graduation was high school GPA. Each quarter-point increase in high school GPA was associated with a 1.3-fold mean increase in the odds of graduating from UCD; with a 1.4-fold increase in the odds of graduating with a degree in biology; and a 1.9-fold increase in the odds of graduating with a degree in biology and cumulative GPA ≥ 3.0 . Clearly, high grades in high school predict high grades in college. Notably, this relationship holds even without including measures of high school quality.

Table 5
Observed academic outcomes by group

Academic Outcome	BUSP		Comparison Group	
	<i>n</i>	%	<i>n</i>	%
Graduated from UCD	275	69	613	70
Graduated in biology	135	34	307	35
Graduated in biology with ≥ 3.0 GPA	48	12	130	15
Total	397	100	877	100

Table 6

Effects of program participation, demographic characteristics, and academic preparation on academic outcome: logistic regression results

Variable	Graduated from UCD ^a			Graduated in Biology ^b			Graduated in Biology With ≥ 3.0 GPA ^c		
	<i>B</i>	SE <i>B</i>	Odds Ratio	<i>B</i>	SE <i>B</i>	Odds Ratio	<i>B</i>	SE <i>B</i>	Odds Ratio
Program participation	0.21	0.14	1.24	0.39	0.14	1.48**	0.39	0.22	1.48
Asian ethnicity ^d	0.16	0.17	1.17	0.39	0.15	1.47*	0.01	0.21	1.01
Female	0.35	0.14	1.42*	-0.25	0.14	0.78	-0.03	0.20	0.97
High school GPA ^e	0.23	0.05	1.26**	0.33	0.05	1.39**	0.62	0.08	1.87**
Math SAT ^f	0.03	0.04	1.03	0.17	0.04	1.18**	0.22	0.06	1.25**
Verbal SAT ^f	0.03	0.04	1.03	0.05	0.04	1.05	0.21	0.06	1.23**
Admissions status	-0.36	0.19	0.70	-0.21	0.23	0.81	-0.50	0.55	0.61

Note. ^aModel $\chi^2(7, N = 1213) = 80.056, p < .01$.

^bModel $\chi^2(7, N = 1208) = 179.536, p < .01$.

^cModel $\chi^2(7, N = 1208) = 238.988, p < .01$.

^dAsian ethnicity is the reference category, and consists primarily of Filipinos, who at that time had been considered an underrepresented minority. Other Asians (excluding Pacific Islanders) are not considered to be underrepresented minorities according to University of California policy.

^eMeasured in quarter-point increments, and calculated using only the academic courses (A–F requirements) taken in the 10th and 11th grades; with honors and AP credits capped at 8 semesters.

^fMeasured in 50 point increments.

* $p < .05$; ** $p < .01$.

Math SAT I score was also associated with persistence to graduation in a biology major. Each 50 point increase in math SAT was associated with an 18% increase in the odds of this outcome and a 25% increase in the odds of graduating in biology with a GPA ≥ 3.0 . This connection is likely to reflect the requirements for calculus and statistics for graduation in these majors. Corroborating evidence for the importance of mathematics preparation comes from including initial math placement in the logistic regression model. Students who were required to take a remedial pre-calculus course were only one third as likely to graduate with a major in biology as those who were calculus-ready at entry. Verbal SAT scores are associated with high cumulative GPAs of biology majors, with each 50-point increase in verbal SAT score associated with a 23% average increase in the odds of this outcome; this is perhaps related to the small positive association between verbal SAT score and persistence in Introductory Biology observed above.

Certain demographic characteristics are predictors of academic outcome in these models. Observed numbers indicate that females graduate at a higher rate than males (72% vs. 64%); controlling for the other variables in the model, females had 42% greater odds of graduating from UCD than males (Table 6). However, the sex advantage is reversed for graduation rates in biology majors. Forty percent of male students actually graduate with a degree in biology, compared with only 32% of females. This does not show up as significant in the logistic regression data, because the large difference in math SAT scores between males and females largely accounts for the discrepancy (the mean math SAT score for males was 542, for females it was 501 ($F(7, 1220) = 51.99, p < .01$).

Lastly, Asian ethnicity is associated with a 47% increase in the odds of graduating in biology, the logical extension of the strong association observed between Asian ethnicity and persistence in basic prerequisite math and science courses (Table 6).

Research Participation and Graduation Outcomes

To determine whether research experience is important to student persistence through college, and, more specifically, to persistence and performance in biology majors, we carried out an intra-group analysis. The graduation outcomes of the 70% of BUSP students who elected to participate in research for one term or more (“researchers”) were compared with the graduation outcomes of the remaining 30% who chose not to do research (“non-researchers”).

Table 7 demonstrates the striking impact of research participation on the three graduation outcomes of interest used in the above analyses. Calculating unadjusted (or observed) odds ratios from the graduation rates in Table 7 indicates that student researchers have 2.4 times the observed odds of graduating from UCD in any major than students who did not participate in research. Research experience is even more strongly associated with graduation in the biological sciences: student researchers had 4.1-fold greater odds of graduating in the biological sciences, and 7.3-fold greater odds of graduation in biology with a ≥ 3.0 cumulative GPA, than non-researchers.

These observed odds ratios appear to demonstrate a linkage between undergraduate research experience and academic success, yet the causal direction remains unclear. That is, does research impact student persistence and performance, or is it simply that students who are destined for success choose to do research? Comparing the demographic characteristics and academic preparation of the 278 BUSP student researchers with the 119 non-researchers, we find that the two groups have essentially the same demographic characteristics, but differ on measures of academic preparation. Student researchers were far less likely than non-researchers to have been admitted by Special Action (27% vs. 37%), had higher high school GPAs (3.47 vs. 3.29), and somewhat higher math SAT (503 vs. 486) and verbal SAT scores (423 vs. 403).

To determine whether any of these characteristics are responsible for the greater success of student researchers, we controlled for the differences between the groups through logistic regression analysis. The predicted odds ratios are somewhat smaller than the observed odds ratios, but are still substantial: research is associated with a 1.9-fold increase in the odds of graduation from UCD in any major, a 3.9-fold increase for graduation in the biological sciences, and a 6.6-fold increase in graduating in the biological sciences with a ≥ 3.0 cumulative GPA (Table 7). These data clearly demonstrate the association of research involvement with BUSP students’ academic success.

Table 7
Influence of research participation on academic outcomes: observed graduation rates and observed and predicted odds ratios (program participants only)

Academic Outcome	Observed Rates						Logistic Regression Model			
	Total		Researchers		Non-Researchers		Odds Ratios		B	SE B
	n	%	n	%	n	%	Observed	Predicted		
Graduated from UCD ^a	275	69	209	75	66	56	2.4	1.88*	0.25	0.63
Graduated in biology ^b	135	34	117	42	18	15	4.1	3.84**	0.32	1.34
Graduated in biology with GPA ≥ 3.0 ^c	48	12	45	16	3	3	7.3	6.56*	0.77	1.88
Total	397	100	278	100	119	100				

Note. ^a $\chi^2(6, N = 370) = 32.62, p < .01$.

^b $\chi^2(6, N = 369) = 65.52, p < .01$.

^c $\chi^2(6, N = 369), p < .01$.

* $p < .05$; ** $p < .01$.

Despite the strength of these results, one plausible rival hypothesis suggests that motivational differences exist between researchers and those who opt out of research, and that this differential motivation also differentially affects persistence to graduation and performance. A measure of motivation could be added to our models, ensuring that any systematic difference in motivation between researchers and non-researchers is statistically removed. Completion of the no-credit Pre-Chemistry course offered to all BUSP students in their first quarter at UCD is one such measure of student motivation. To receive a grade of Pass (P), students need only participate in class and complete all the assigned homework. Those who do not pass (NP) are either uninterested or distracted. When passing performance in Pre-Chemistry was added to the statistical models as a proxy for motivation, the results maintain the strong effects of research experience on academic outcome, but were reduced in magnitude by 11–13%. Thus adjusted for motivation, research participation was associated with a 1.7-fold increase in the odds of graduating from UCD ($p = .05$); a 3.4-fold increase in the odds of graduating in biology ($p < .01$); and a 5.7-fold increase in the odds of graduating in biology with GPA of ≥ 3.0 ($p = .02$). A passing grade in Pre-Chemistry is a statistically significant predictor of only one of the three academic outcomes: it is associated with a 2.5-fold increase in the odds of graduating from UCD ($p = .03$).

Although the logistic analyses indicate that undergraduate research is significantly associated with positive graduation outcomes, they cannot help us to understand what constituent elements of the experience are most conducive to student success. Surveys, interviews, and focus groups with former program participants filled this gap by allowing students themselves to describe the relative contribution of different aspects of the research experience. Membership in the laboratory community; individual mentoring by faculty, graduate students, or postdoctoral students; improved time management skills; and understanding of the relevance of basic science classes to future careers in science were commonly mentioned by students as integral to success. One half of alumni survey respondents who performed research claimed that the experience influenced their choice of major and 59% reported that the experience had influenced their choice of career ($n = 56$; some cell sizes are extremely small, hence these data are presented for illustrative purposes only).

However, not all students reported positive research experiences. In apparent contradiction to the statistical data, one half of those who claimed that research had influenced their choice of college major described their research experiences as having deterred them from further laboratory involvement. Of those who reported that research had influenced their career choice, a similar proportion (48%) also reported negative research experiences. This underscores the importance of a carefully designed, developmental research experience for undergraduate students to encourage them to continue in science.

Postgraduate Activities

Surveys, interviews, and personal communications have allowed program staff to track the post-UCD activities of 43% of BUSP participants who entered the program 1988–1994 and compare their activities to a group of 1999 UCD degree recipients surveyed one year after graduation education (Butler, 2001).⁸ The BUSP students for whom we have post-UCD data are not representative of the entire group of 1988–1994 entrants: they were far more likely to have graduated from UCD (89% vs. 69%), were more likely to have graduated in biology (53% vs. 34%), and graduated in biology with a ≥ 3.0 GPA (24% vs. 12%). Therefore, the data presented below, while not representative of BUSP participants overall, is loosely suggestive of the post-UCD activities engaged in by BUSP graduates.

Of these 172 students for whom we have post-UCD data, 62% matriculated in educational programs toward higher degrees, while only 40% of UCD graduates pursued graduate degrees (Butler, 2001). Twenty-six percent of the BUSP alumni had completed or were currently in doctoral programs, with the majority in medicine (18% of tracked students). This is consistent with the pre-medical aspirations of an overwhelming majority of entering BUSP students. On the other hand, 8% of BUSP alumni are in doctoral programs, with three-quarters in biology-related disciplines. In addition to boosting the number of minorities in the science pipeline, this is twice the campus average, as only 4% of UCD graduates overall pursued academic PhDs (Butler, 2001).

Of the remaining BUSP alumni pursuing higher degrees, 21% were in masters programs, and 16% earned or were pursuing teaching credentials or Masters of Education, compared with 7% of UCD graduates overall (Butler, 2001). While creating the next generation of minority teachers is not an explicit aim of the program, the potential contribution of these teachers to instructing the next generation of minority scholars is immense. However, it is sobering to note that most of those who earned teaching credentials did not graduate in the biological sciences: 27% of non-biology majors and 9% of biology majors earned teaching credentials. Only one student with a biology major and a high GPA opted to obtain teaching certification.

Postgraduate educational pursuits vary by graduation outcome. Non-biology majors and biology majors pursued graduate education at similar rates; however biology majors who graduated with ≥ 3.0 GPAs were far more likely than biology majors with lower GPAs to pursue graduate education.⁹ More than 60% of the high-achieving biology graduates went on to doctoral or medical professional work, compared with 25% of biology graduates with GPAs of < 3.0 . Those with lower GPAs were most likely to pursue teaching credentials or masters degrees.

One Participant's Experience

Some program participants have overcome substantial obstacles to graduate in biology and pursue graduate or professional degrees. A is one such participant. She grew up as the daughter of migrant farm-workers, and is the first person in her family to attend college. Although her parents were very supportive during her school years, their lack of experience with higher education made it difficult for them to understand the college experience or to give her the benefit of parental advice on academic matters. However, she notes that her parents taught her the value of hard work. It is through the combination of native intelligence, hard work, and dedication to her goal of becoming a physician that A graduated from UCDs with a baccalaureate in biological sciences, a cumulative GPA of 3.21, and acceptance to a prominent medical school.

A's goal to become a physician providing quality medical care for low-income people developed during her childhood when, due to a lack of health insurance, her family's medical needs were met through county migrant-worker health clinics, *curanderos* (folk medicine practitioners), or not at all. During her undergraduate career, she pursued her interest in community medical practice by working at a student-run health clinic that provides care to low-income Hispanic people in the Sacramento area. At the clinic, she was responsible for arranging follow-up treatment and referrals to specialists for the patients. This was an especially challenging job because none of the patients had medical insurance or the means to pay the full costs of treatment. Thus, A often arranged for patients to receive reduced-price treatment and devised billing arrangements that would allow patients to pay their bills in installments. In addition, she was actively involved in research beginning as a freshman, progressing to conducting research to develop palliative AIDS vaccines for which she received a research award, and culminating in research in the laboratory of an internationally renowned researcher in Virology as a participant in a summer research program.

A's academic achievements have been recognized through numerous awards. In reflecting on her experiences at UCD and participation in BUSP, A notes that the most important parts of BUSP for her were the supplemental course work and the program-sponsored laboratory work:

Although I was very self-motivated, the strong academic foundation I developed as a result of the BUSP pre-chemistry and supplemental chemistry and math classes helped me to achieve at a higher level. I was able to study more effectively and efficiently in study groups, as encouraged by the BUSP teachers and advisors. This meant that I could do well academically, and have time to pursue other activities such as [the clinic] and laboratory research. Working in the lab made course work more relevant, and because I was able to apply the course work knowledge to real problems, my understanding of the material was strengthened. This contributed to my self-confidence, and made me more comfortable when approaching instructors for help with course work. The BUSP funding for my research was essential because I had to work to support myself through college. Without BUSP, my studies might have taken longer to complete, and I might not have been as successful. BUSP lowered the hurdles [to success] for me.

Discussion

Study Limitations

Some obvious limitations to this analysis exist. The most serious of these is the ex post facto research design, in which students were not randomly assigned to BUSP or the Comparison Group. Nonetheless, external validity issues associated with nonrandom assignment may be ameliorated by using multivariate statistical analyses with appropriate controls (Mohr, 1995; Rossi, Freeman, & Lipsey, 1999), a procedure employed throughout this program evaluation. Somewhat less significant issues are the lack of adjustment for high school quality in the high school GPA data and lack of availability of socioeconomic data.⁴

Conclusions

This analysis demonstrates that the Biology Undergraduate Scholars Program has been successful in its original goal of increasing the number of minority students who persist in science throughout their undergraduate careers. Greatly improved student persistence and performance in basic math and science courses can be attributed to supplemental instruction and possibly other, unmeasured, facets of the program. These other aspects of the program include academic and personal advising, peer support due to strong group cohesion, and a group ethos of success. The BUSP model, featuring an enriched curriculum for a cohort of science-focused students in the crucial freshman and sophomore years, could be readily adopted by other minority-serving institutions. BUSP participation was also associated with improved persistence in biology majors to graduation and at least part of that effect can be attributed to research experience. We are, however, not starting with a blank slate. High school GPA was the single strongest predictor of student performance in college, and SAT scores also offered some predictive value.

The greater educational choices for program participants with high GPAs reflect the 3.0 minimum GPA required by many schools for admission to doctoral programs. Thus, programs that aim to substantially increase the minority population in the doctoral science pipeline must focus on increasing the proportion of program participants who attain high grades in the sciences. However, our data suggest that those who graduate in biology with GPAs of <3.0 may still make it to graduate school, albeit at lower rates. For students with less competitive GPAs, masters degree

programs may be an end in themselves or a strategy to ratchet up to a doctoral program or medical school. Furthermore, the higher educational attainment of BUSP participants compared with UCD graduates overall is itself a notable achievement, especially since BUSP students' academic preparation is at the low end of the campus range. This suggests that the program itself instills the value of, and means to, graduate educational attainment.

There are clear policy implications of this analysis. We show that a program providing academic enrichment, personal support and research experience can substantially reduce the attrition of underrepresented minority students from biology, and that these students can—and do—go on to challenging and successful careers. Therefore, the substantial investment of resources required to mount such comprehensive programs is an investment well spent and should be continued by the National Institutes of Health, National Science Foundation, private foundations, and universities. Over time, and with improved focus on high levels of achievement,¹⁰ the combined effect of successful intervention programs could ameliorate racial/ethnic differences in academic outcomes, ultimately diversifying the scientific enterprise.

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Appendix A: Data File Variables

Main Data File (BUSP and Comparison Group Included)

Student ID number

Program participation (BUSP participant/comparison group)

Year of entry to UCD

Term and year of first UCD enrollment

Sex

Race/ethnicity

High school grade point average (GPA) (calculated using only the academic courses (California A-F requirements) taken in the 10th and 11th grades; capping honors and AP credits at eight semesters)

Math SAT I

Verbal SAT I

Admissions status (regular or special action)

EOP status

Term and year of graduation

Graduation major

Degree type

Cumulative UCD GPA

Number of terms enrolled

Mother's educational attainment

Father's educational attainment

Mother's occupation

Father's occupation

BUSP Participants Only Data Files

Supplemental Workshops Data File

Supplemental workshop enrolled in

Term and year of workshop enrollment

Workshop grade

All variables from main data file
 Research Experience Data File
 Term and year of laboratory placement
 Research mentor name
 All variables from main data file

Appendix B: Biology Majors at the University of California, Davis, 1988–1996¹¹

Animal Science
 Avian Science
 Biochemistry
 Biological Sciences
 Biotechnology
 Botany
 Cell Biology
 Environmental Toxicology
 Evolution and Ecology
 Exercise Science
 Food Biochemistry
 Food Science
 Genetics
 Microbiology
 Neurobiology, Physiology, and Behavior
 Nutrition Science
 Physiology
 Plant Biology
 Plant Science
 Wildlife and Fisheries Biology
 Wildlife, Fish and Conservation Biology
 Zoology

Notes

¹ Asian Americans were more likely to major in S & E fields than any other racial/ethnic group, but all other groups were similarly represented in these majors (Astin & Astin, 1992; National Science Foundation, 2000).

² Underrepresented minority groups for the University of California at the time BUSP was started included Native Americans, Alaska Natives, African Americans, Hispanic Americans, Filipino Americans, and Pacific Islanders. Filipino Americans were dropped as an Affirmative Action category in 1989 because their proportion in the University of California system had equalized to that of the Filipino representation in the state as a whole. However, Filipino students retained access to special services due to their relatively low graduation rates (Student Affairs Research & Information, 2000).

³ Some students lack required courses, while others may have low grades or test scores.

⁴ Unfortunately, some variables postulated to be associated with educational attainment were unavailable to us or were only available for some students. For example, parental education and occupation were only available for those who entered college in 1993 and 1994, and were hence used to a rather limited extent^{Q4}. Information on students' financial aid status proved even more difficult to procure for most students in the file, and while this important variable would have been extremely useful for our analyses, it was not possible to include it. However, although socioeconomic variables are frequently shown to be associated with educational outcome (see, e.g., Tinto, 2000; Astin, 1982), preliminary analysis using the

data available for the 1993 and 1994 entrants found no significant relationship between parental educational attainment and academic outcome. Whether this is due to our particular population of disadvantaged students, inadequate measurement of parental income and education, or is a valid effect is not known.

⁵The median time to graduation for both groups was 4.7 years, with 93% graduating in less than 6 years. Comparison group students were slightly faster at obtaining their degrees, however: 94% of Comparison Group students graduated within 6 years, compared with 91% of BUSP students.

⁶Odds differ from probabilities in that probabilities are the likelihood of an occurrence expressed as a fraction, while odds are the likelihood of an event divided by the likelihood of the event's absence, or the ratio of the probability of an event versus the probability that the event will not occur. Thus, an outcome with a 50% probability has odds of 1.0.

⁷Just as linear regression models allow us to analyze the effects of a set of independent variables on an interval or ratio-level-dependent variable, logistic regression modeling permits the analysis of multiple independent variables on a nominal dependent variable. Logistic regression demands that we regress not on the dependent variable itself, but on a transformation of the dependent variable to the log odds of the dependent variable. The impact of each independent variable on the log odds of the dependent variable is expressed as the estimated odds ratio and has an associated *p*-value.

⁸This reported the results of a survey of 1999 UCD degree recipients 1 year after graduation, with a response rate of 44.5% (*n* = 1106). As is typical of such surveys, the distribution of respondents was skewed, both demographically and by academic discipline and performance. Whites and females are somewhat overrepresented (Whites were 47% of 1999 graduates, but were 51% of survey respondents; females were 58% of the graduating class, but were 63% of respondents), as were those with higher GPAs (the mean GPA for the sample was 3.16, compared with 3.09 for the graduating class as a whole). Biology majors were also slightly more likely to respond to the survey (biology majors were 20% of graduates but were 22% of the survey sample). Selection bias for follow-up on the BUSP group makes the two groups somewhat more comparable, though the BUSP group is, obviously, entirely made up^{Q5} of racial/ethnic minorities who entered college intending to major in the biological sciences.

⁹78% of those who graduated in Biology with a ≥ 3.0 GPA went on to graduate studies, compared with 57% of those who graduated in Biology with GPAs of < 3.0 .

¹⁰What was lacking in the early program design was an explicit focus on high levels of achievement, which changed in 1995. Because of the high attrition rate of students poorly prepared in mathematics and English, we no longer accepted these students in their freshman year. They are deferred, that is, required to spend their freshman year making up deficiencies in these subjects with BUSP participation postponed until the sophomore year. A BUSP honors program now provides activities for selected high-achieving juniors and seniors, organized around research activity and an accompanying seminar course. Another change since 1995 is the inclusion of disadvantaged students from all racial/ethnic backgrounds, making for a more heterogeneous group. In 2001, BUSP began offering a research skills course, conducted during the summer after the freshman year, to prepare students to function at a higher level in the research laboratory.

¹¹Majors are constantly in flux; therefore, some listed majors may be overlapping.

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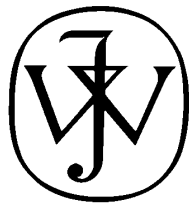
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