

Are Diversity Investments Worthwhile? An Analysis of Impacts of Diversity Efforts on Graduation Rates for Engineering Students

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ABSTRACT

Diversity efforts are now a standard parts of most engineering colleges in the United States, but how *effective* are these efforts overall? Are they worth continued and perhaps increased levels of investments in the form of personnel, space, and scholarships or tuition support? Are there some efforts that are more effective than others? Using data and information gathered from 63 engineering colleges through a stratified random sample of the 2007 ASEE (American Society for Engineering Education) list of engineering colleges, we analyze the correlation among over 30 diversity efforts (such as scholarships and informal events) and the most foundational indication of diversity effort success: the representation of women and minorities in graduating cohorts. After analyzing these correlations individually, we combine several into measures of diversity effort “extensiveness,” hypothesizing that these efforts become more effective when combined. The results indicate that scale and status matter: the majority of diversity efforts are significantly correlated with diversity among graduates in schools of certain sizes and private/public status. We conclude by discussing which factors appear to provide the highest correlation with graduation rates and how these factors may be dependent on the scale of the engineering college or the public/private status of the university. In general our results suggest that diversity efforts are worthwhile investments, although additional research on the specific benefits and costs of various programs would be needed to determine optimal levels of investments, and to investigate related employment and pipeline issues.

INTRODUCTION

Over the last three decades, academic's answer to the continued lack of gender and racial/ethnic diversity in engineering and sciences has been to develop and implement "diversity efforts:" investments of time, money, personnel and space geared toward recruiting and retaining women and ethnic/racial minorities in engineering majors. Program administrators trade best practices informally through word-of-mouth and formally through outlets such as the *Journal for Women and Minorities in Science and Engineering*, the National Association of Minority Engineering Program Administrators (NAMEPA) or the Women in Engineering ProActive Network (WEPAN). There is an abundance of information for administrators and faculty members who hope to start, improve, or expand diversity efforts at their intuitions (see for e.g. Malicky, 2003; National Academy of Sciences, 2006) but much of this information is anecdotal and a cataloging of resources spent.

Despite these well-intentioned efforts, we have little systematic national-level assessment of these efforts in whole or in part. If we are to understand how to better invest for achieving increased diversity—or whether we should invest in them all—we need a quantitative analysis of which efforts are correlated with levels of minority and women representation in graduating cohorts, and to begin to disentangle the impacts of alternative programs.

The purpose of this paper is to begin to explore how investments in diversity programs at American engineering colleges may affect the representation of women and minorities in graduating bachelors' degree cohorts. In addition to identifying which specific diversity efforts are most strongly correlated with high representation of women and minorities, we examine the potential importance of the *extensiveness* of these diversity efforts. With this analysis, we are able to determine (a) whether diversity programs are correlated with higher representation of women and minorities, (b) which diversity efforts appear to be most effective in fostering a diverse graduating cohort, (c) whether multiple diversity efforts are more than the sum of their parts, and (d) whether these diversity efforts are "one size fits all," or if their effectiveness depends on program size and public/private status of the institution.

We begin by reviewing the standard assumptions about diversity efforts in engineering institutions and key factors that are likely to impact graduating rates, then describe our approach to quantifying these efforts, present our analysis, and draw some preliminary conclusions about their effectiveness and needed further research.

BACKGROUND AND INDICATORS: DIVERSITY EFFORTS IN U.S. ENGINEERING COLLEGES

Nearly one-third of US institutions offering engineering degrees have formal diversity programs with the distinct purpose of promoting the success of women and minorities in engineering degrees (Landis, 2005). The majority of

engineering colleges have diversity initiatives, such as organizations like Society of Women Engineers and the Society of Black Engineers which are geared toward minority and women students, but the extensiveness—and effectiveness—of these efforts varies widely. Though most diversity initiatives assess their success in-house or report their results to other administrators through venues such as NAMEPA and WEPAN, little data exists that compares the characteristics of these efforts with the paramount end result: the graduation of women and minorities with engineering degrees. We are aware of only one study, by Knight and Cunningham in 2004, that systematically analyzes the character of engineering diversity programs. Their study, which gathered qualitative data on 26 Women in Engineering (WIE) programs, found that the most “successful” programs were those that were able to secure support from administrators, faculty, and the students themselves, and those that extended beyond the boundaries of their institutions into local K-12 classrooms (Knight & Cunningham, 2004). However, the authors only focused on programs directed toward women and those that were extensive and well-established, resulting in a small and possibly unrepresentative sample.¹ The authors admit that they are unable to present even standard descriptive statistics due to data inconsistencies. While these findings help us describe the structure of these programs, they do not tell us how *effective* the programs are at graduating diverse cohorts of engineers. In order to determine what factors of diversity programs are important, and if diversity programs are indeed effective, we attempt a systematic *quantitative* analysis, comparing these efforts to the representation of women and minorities in the graduating cohorts of engineering institutions.

Guided by the literature on engineering diversity programs, we examine the correlation between the following diversity efforts and the representation of women and minorities in the 2007 graduating undergraduate cohort at 63 institutions. The diversity efforts are explained below, and the source of the information for creating each measure and our analytic strategy is discussed in the Methods section.

Diversity Effort Indicators

Percentage of Women and Minorities in the Engineering Faculty

It is well-known in engineering circles that having faculty role-models is key to the retention of women and minorities in engineering (Bauer, 2008; Sandler, Silverberg, & Hall, 1996; Traweck, 1988). Women and minority faculty not only serve as visible examples of success, but also as advisors and mentors. More importantly, women and minorities are more likely to seek advice and assistance from same-group faculty members (Valian, 1999;

¹ Their criteria of “healthy” programs were those where a WIE director worked in a paid position more than 25% on the program, programs that has been in existence for at least 3 years, and those which included outreach efforts.

Wallace & Haines, 2004). We examine the correlation between the representation of women and minority graduates and the following indicators: the percent women in the faculty in 2006 and 2001, the percent minority in the faculty in 2006 and 2001, and the changes in the representation of women faculty and minority faculty between 2001 and 2006. We include the measures at two different points in time to determine whether it matters if faculty diversity is relatively entrenched in the institution, and we account for the change in percentage to test whether engineering colleges whose faculty diversity efforts are energized also seem to be attracting and retaining women and minority students.

Formal Diversity Program

A major variable in our analysis is whether or not the institution has a formal diversity program. We define “formal” by the existence of a named program, “Engineering Minority Program” for example, that is identified on their web site. Other studies that have compared diversity efforts across programs have focused almost exclusively on institutions with formal programs (see, for example, Knight and Cunningham 2004). Our sample of schools includes both those with and without formal programs.

Diversity efforts targeted to women and specific minorities

We have several indicators of whether or not diversity efforts are specifically targeted at certain demographic groups. In geographic areas with higher percentages of minority groups than the US average, such as Hispanic-Americans in the American southwest, diversity efforts directed explicitly towards specific demographic groups may increase the numbers of students in those groups in the graduating classes. Specifically, we have indicators for programs that specifically serve African-American, Hispanic, Asian, and Native-American students, international students, and students with disabilities. Other indicators capture a focus on students from underprivileged backgrounds, such as students from lower socio-economic families, students who are academically under-prepared, or first-generation college students.

Scholarships

Many engineering colleges attempt to recruit and retain women and minorities through full or partial diversity scholarships (Astin, 1993). These scholarships help fiscally by relieving the burden on students to work, and symbolically, by showing the students that they are valuable parts of their engineering departments (Landis, 2005). We measure whether or not engineering colleges offer scholarships for women and minorities that are outside traditional academic or need-based scholarships open to all engineering students.

Formal and Informal Events and Meetings

One of the most important roles of diversity programs is to break up the isolation that many women and minority engineering students face and bring them together (Cech, 2007; McIlwee & Robinson, 1992; McLoughlin, 2005; Sandler et al., 1996). Events like mixers, barbeques, guest speakers, or special dinners help build community among the students and allow them to advise one another on how to cope with difficult situations (Cech, 2006; Landis, 2005). Events can be formal, scheduled activities that allow engineering colleges to present a specific message to women or minority students, or informal, casual events where students have the opportunity to mingle and make friends. We examine the effects of both of these types of events.

Internships

Internships are one of the best experiences for energizing students' interest in engineering fields and preparing them for the workforce (Eccles, 2007; McIlwee & Robinson, 1992). Connecting women and minority students with internship opportunities is an effective way to give them real-world working experience and make them successful on the job market. While internships may be more effective in advancing the diversity of the engineering workforce than the diversity in graduating cohorts, they are a statement of commitment to women and minority students' long-term learning and success in the profession. For our purposes, only colleges that have links to internships explicitly for women or minority students are counted in this variable.

Outreach Activities

Knight and Cunningham (2004) argue the importance of K-12 outreach for the success of engineering diversity programs, but did not describe how outreach efforts might help diversity in the student body. Obviously, if engineering colleges are reaching out to K-12 classrooms, they may see a spike in the enrollment of women and minorities in their engineering degree programs. However, it is not clear that engaging current women and minority students in outreach activities will help retain them in engineering majors.

Pre-College Summer Bridging Programs

Pre-college summer bridge programs connect with women and minority students before they enter their freshman year, hoping to ease the often-tumultuous transition into engineering majors. Bridge programs range in their purpose and length, but most include introductions to faculty, refresher mini-courses on foundational math and science concepts, and networking and social events (Landis, 2005).

Study Groups

Study groups are an integral part of success in engineering. Students who do not become incorporated into study groups early are tremendously disadvantaged in their coursework (McIlwee & Robinson, 1992). Often, women and minorities are not incorporated into study groups because they are excluded by their male or non-minority peers or they disengage themselves from study groups because they are treated as tokens (Leslie, McClure, & Oaxaca, 1998; Robinson & McIlwee, 1989; Seymour & Hewett, 1997). Many engineering colleges facilitate women or minority study groups to mitigate these disadvantages. In addition to study groups, we examine whether or not colleges have dedicated physical space where students can participate in such groups. Space is a premium on college campuses, so having a room or center dedicated to diversity efforts sends a message to the students and the rest of the college that diversity efforts are a priority (Landis, 2005).

Mentorship programs

Mentors are vital for the success of all engineering students, but they are particularly important for those who are under-represented in the profession (Cole & Cole, 1973; Dryburgh, 1999; Fox, 1991; Long, 1990). Many diversity programs link women and minority students with more advanced students in their programs or with practicing engineers in industry. These interactions have been shown to build student confidence and solidify their interest in the profession (Wallace & Haines, 2004). While mentorship programs are quite expensive and staff-intensive to operate, they are highly-regarded by students.

Academic-Themed Residence Hall Floor

Combining elements of formal and informal events, dedicated spaces, and facilitated study groups, academic-themed residence hall floors are now being successfully implemented by engineering college administrators.

Chapters of women and minority engineering student organizations

Student organizations such as the Society of Women Engineers (SWE) and Society of Black Engineers require minimal investments from engineering colleges, but provide women and minority students with social spaces to gather, collectively address members' concerns, and opportunities to network and mentor one another (Pierce, 1990). While the participation and extent of activity in such organizations varies markedly, their very existence may help retain women and minority students.

Number of Staff Dedicated to Diversity Efforts

Our final measure of diversity efforts is the number of staff dedicated to colleges' diversity efforts. We count "staff" as the number of people who are listed as directors, assistants, and staff directly associated with diversity efforts. We assume that institutions with five staff coordinating diversity efforts will have more extensive and encompassing programs than colleges with only one.

Diversity Effort Measures

In addition to the properties and efforts described above, we divide the schools into three categories by size: small schools (graduate less than 150 engineering students), medium schools (graduate more than 150 students but less than 400), and large schools (graduates more than 400 students). These divisions are based upon the total graduating cohorts of the sample divided into thirds. We hypothesize that school size matters in the extent and effectiveness of diversity effort. We also divide the sample by their public and private status, theorizing that private schools, which typically have more monetary resources, will invest in more of these efforts on average than public schools. Whether their efforts are more effective than those in public schools, however, is an open empirical question.

We also hypothesize that diversity efforts are more than the sum of their individual components and that there are economies of scale associated with grouping these efforts. The *extensiveness* of diversity efforts on different axes should co-vary with the representation of women and minorities over and above the effects of the individual components. Therefore, we created several extensiveness measures by running a factor analysis on all of the diversity components and creating linear scale variables from those that hung together in themed groups.² We created the following five measures of diversity effort extensiveness:

Extent of Inclusiveness of different racial/ethnic groups (alpha=.816):

² In order to create the scale variables, we ran a factor analysis in SPSS with all of the diversity effort indicators in our study. This process identifies variables that "hang together," or behave similarly, by reporting both the number of individual axes of covariance it identifies and the strength by which each variable covaries on each individual axis. Each variable was assigned to the axis along which it had the strongest covariance. We then examined each axis for conceptual similarity. Out of six axes the factor analysis identified, we found five of those groups to be conceptual groupings as well.

To test whether we could create scale variables from these groupings, we found the reliability measure *alpha* for each grouping. All had an alpha above .700, the standard threshold for scale creation. We created scale variables by summing the variables in each group to create a single variable. These scales are useful because they allow for more variability in the scale variable and they are more robust measures of the concept in question because they are based on multiple indicators.

Serves African American students specifically
Serves Hispanic students specifically
Serves Asian students specifically
Serves Native American students specifically
Serves under-prepared students specifically

Extent of Career-Oriented Resources (alpha=.859):

Offers separate scholarships for women and/or minorities
Offers Internships
Offers Outreach opportunities
Facilitates Mentoring

Extent of Dedicated Social and Physical Space (alpha=.824):

Offers a bridging program
Facilitates study groups or tutoring
Has a dedicated physical space or office for the program
Has a named and funded diversity program

Extent of Hosted Events (alpha=.775):

Hosts formal events
Hosts informal events

Extent of Minority Student Organizations offered (alpha=.749):

Offers women engineering student organizations
Offers minority engineering student organizations

For the reasons outlined above, we hypothesize that these diversity efforts and program characteristics are positively correlated with high levels of women and minority representation in graduating cohorts. After describing our data and methods, we present descriptive statistics on the colleges in our sample and discuss the results of our analysis.

DATA AND METHODS

Data

Our data set consists of 63 engineering colleges from a stratified random sample of the 2007 ASEE report on 345 American engineering institutions. Arranging by the percent women and minorities in each school's 2007 graduating cohort, we selected the 10 colleges with the strongest representation and the 10 colleges with the lowest representation³ (ASEE, 2007). (We categorized the ASEE-collected categories of African-American, Hispanic, Native American, and Asian students as "minorities.") We randomly selected 43 institutions from the remaining 325 schools. This procedure stratified our sample to represent high-minority, mid-minority, and low-minority schools. In addition to the representation of women and minorities at each institution, we obtained information on

³ Because we are interested in the ability for majority white colleges to attract and retain a diverse student body, we excluded Historically Black Colleges from our sample.

the total number of graduates in 2007 and the percentage of women and minority in the faculty from the 2006 and 2001 ASEE reports (ASEE, 2001, 2006).⁴

We collected the remaining information by scouring each college's websites for information regarding diversity efforts. To minimize the probability that we did not miss a component that was not attached to the engineering college's website, we utilized the university website's main search engine as well as a generic web-wide search engine. Using this procedure we may have missed components that exist at individual engineering colleges but are not represented on the web media. . Although subject to some biases, we chose to collect the data in this way for several reasons. First, as in the Knight and Cunningham study (2004), interviews with diversity personnel would be biased toward those schools which have formal diversity programs and/or employed diversity personnel. It was important to gather information from schools with extensive diversity efforts as well as from schools with no diversity efforts at all.

Second, websites are a primary way prospective and current students find out about diversity efforts that interest them. If a college has a chapter of SWE, but does not advertise the student organization anywhere within their college's website domain, students who search for SWE online may be unaware that the chapter exists. In other words, accessing this information in the way an inquisitive student might gives us a real-time representation of how these efforts correlate with diversity in the graduating classes. Third, the "under-reporting" of the various components by our data gathering method underestimates our findings: significant correlations are significant *in spite of* any absent data.⁵ We feel that the analysis conducted with our medium-N sample size outweighs any potential limitations with the data collection process.

Methods

We begin by presenting the means and standard deviations on all variables for our entire sample and broken down by school size and public/private status. All variables are dichotomous except for the percent representation variables, the number of staff dedicated to diversity efforts, and the "extensiveness".

⁴ The data ASEE collects for its annual report is self-reported by administrators on a college-by-college basis. While we acknowledge there may be some over-reporting of numbers of women and minority students or women and minority faculty, we do not think this introduces a *systematic* bias in our findings. In other words, we expect larger programs would be as likely to over-report as smaller ones, private schools as likely as public schools, and schools with extensive programs as schools with no programs at all. This is akin to the non-systematic over-reporting of personal salaries or height that is standard in social science research (Babbie, 2004; Baker, 1999).

⁵ As with the ASEE self-reporting of demographic statistics, we do not expect there to be a *systematic* bias by school size, prestige, or effectiveness in diversity efforts in the difference between the diversity efforts in existence and those that actually appear on college-affiliated web media.

We run standard bivariate correlations to examine the relationships between our indicators and the representation of women and minority graduates. Asterisks indicate where correlations are statistically significant based on two-tailed tests. Table 2 presents the bivariate correlations for the individual variables and Table 3 presents the correlations for our scale variable “extensiveness” measures. We discuss these results in the concluding section.⁶

RESULTS

Descriptive Statistics

Looking at the bottom of Table 1, the first statistic of note is that the majority of medium and large engineering schools have formal diversity programs. The percentage of large schools with diversity programs, 83%, is impressive. While only 40% of small schools have formal diversity programs, the representation of women in their programs lags large schools by only three percentage points. The representation of minority students in small engineering colleges, however, lags the large schools by 10 percentage points. There are also substantial differences between small and larger colleges in the change of women and minority faculty between 2001 and 2006. Large colleges increased their representation of minority faculty by 68%, compared to the 46% increase at small colleges. The sizeable increase in representation of minority faculty at larger colleges could be partly due to their larger faculty body, which because of higher turnover may have more opportunity and resources to bring in women and minority faculty members.

Just over 60 percent of both private and public schools have formal diversity programs, but private schools are able to attract 4.6 percentage points more women and 1.3 more minority students than public schools. Private schools had substantial increases in the percent of women and minority in their faculty between 2001 and 2006, but do not have representation much different from public schools.

[Insert Table 1 about here]

The existence of programs that explicitly serve women or specific minority groups reflects the difference in the existence of programs at the different-sized schools, but one trend is very evident: larger schools are more likely to have programs directed at specific demographic groups. In fact, only 16% of small schools have programs directed toward “minority” students in general.

⁶ We chose to use bivariate correlations instead of causal models such as OLS regression because the relationship between diversity efforts and diversity in the student body is certainly bi-directional. We plan to run a lagged analysis of the representation of women and minorities in the graduating class of 2012 and our current data on the 2008 status of diversity efforts of these universities. There, causal analysis will be appropriate because we can be assured that the diversity efforts were in place at the time the students entered college.

The majority of schools in each group offer scholarships to women and/or minority engineering students, but 82% of large schools offer such scholarships, as compared to 58% of small schools. Larger schools are also more likely to have formal and informal events and to facilitate mentoring than medium-sized or small schools. These differences may be the result of a stark difference in the number of staff dedicated to diversity efforts. Small colleges average less than one person per institution, while large colleges average more than 2.5 staff per institution.

Though private schools generally have access to more resources to support diversity efforts, it appears that *public* schools have more extensive and varied programs. They are more likely to offer scholarships, have formal meetings, engage in outreach activities, offer bridge programs and facilitate study groups. Their inclusiveness measures are twice that of private schools, and they have larger measures of career-related resources, hosted events, and overall extensiveness.

Medium and large schools have more extensive programs on every measure except the extent of student organizations offered. The aggregated measure of extensiveness is particularly telling: small schools have an average of 4.63 different types of diversity efforts, while medium and large schools have 7.27 and 8.76, respectively.

The strength of large schools on these measures is not necessarily an indication by itself of a greater dedication to diversity than smaller schools. More students may imply more total resources, with a greater likelihood that additional resources are available for diversity programs with many different dimensions. However, additional resources do not automatically mean more extensive or effective programs, as we see with the private schools. While this extensiveness and scale may be the reason large schools are able to graduate 1/3 more minority students than small or medium-size schools, this pattern does not hold for the representation of women. The bivariate correlations will help us break down whether these efforts correlate more strongly with the representation of women and minorities in large schools than in smaller schools.

Finally, public institutions have stronger and more extensive diversity programs overall, somewhat in contrast to a prevailing sentiment that better-funded private schools would invest more extensively in diversity efforts. Private schools may justify their lack of investment in diversity efforts by the exclusivity of their admission process.

Bivariate Correlations

Looking to the results for all schools in our sample, we see at the top of Table 2 that the percentage women and percentage minority is highly correlated. This indicates that it is unlikely for a school to be very strong at attracting women and poor at attracting minorities, or vice-versa. It is likely that engineering colleges which dedicate

themselves to diversifying their student bodies do not focus on *only* women or minorities but look to diversify both by gender and race/ethnicity.

Having programs that are targeted to women specifically and to minorities in general are both correlated with higher representation of women, but we find that none of the indicators measuring a targeting of specific demographic groups are significant. We see that scholarships are significantly correlated with women's representation, as is links to internships and mentoring programs. These three factors help women succeed in their programs and help to ease the transition between school and the labor force.

[Table 2 about here]

Facilitated social interaction among women engineering students is also appears to be an important factor in the representation of women. Formal and informal events and having a dedicated physical space are all highly correlated with women's representation. Surprisingly, having chapters of women engineering organizations and having a residence hall floor were both uncorrelated with the presence of women students.

The picture is much less clear in relation to minority representation. Several diversity efforts are marginally correlated with minority representation (having a program that serves minorities, offering links to internships, having a dedicated space to meet, and having chapters of minority organizations), but the only significantly correlated factor was the percent of minority faculty in 2006. We can conclude that having faculty role models is important to the representation of minorities in the student body.

Moving to the group of small schools, many of these patterns are exaggerated. Again, factors that are important to women's success and retention in engineering (scholarships, events, and mentorship opportunities) are significantly correlated with their representation. Formal events are particularly highly correlated with women's representation (.608). Having dedicated space and staff are also correlated with high numbers of women graduates, but this is not the case for minorities or women at medium or large schools.

In contrast to the results for all schools in our sample, many of the same factors correlated with women's representation were also significantly correlated with minority representation. In small schools, it matters for the representation of minority students that there are minority faculty, and that schools offer scholarships, informal and formal events, bridging programs, and mentorship programs. None of these factors are significant for minority representation for schools which graduate more than 150 engineering students per year.

Medium-sized schools have substantially fewer factors which are correlated with high numbers of women and minority graduates. For women, it matters whether their school is private or public, and marginally whether it serves students with disabilities. For minorities, the percent women in the program and the percent minority in the faculty in 2006 are the only significantly correlated factors.

In schools with more than 400 engineering graduates (large schools), we see many fewer clear correlations than in the small schools. Unlike smaller schools, the representation of women is correlated with the percent of women faculty in 2006. As before, both programs directed specifically at women and those offering scholarships and internships are significantly correlated with high levels of women. Opportunities for mentorship and outreach are marginally correlated. The representation of minority and women on the engineering faculty is important for the representation of minority students, and the change in percent minority faculty members between 2001 and 2006 is marginally correlated.

Taking the results for women by public/private status, we see that private institutions do significantly better than public institutions at graduating women. As we found in the descriptive statistics, private institutions actually have less extensive diversity efforts, so this difference in representation of women may stem more from private schools' deliberate recruitment practices than their retention efforts. This difference does not occur for the representation of minority students, however.

A substantial number of the diversity efforts are significantly correlated to women's representation in engineering in public schools: the percentage women is correlated with the diversity represented in the faculty in 2006, with diversity efforts that are clearly directed to supporting women and minorities, as well as those that serve under-prepared students and those from low socioeconomic backgrounds. Women's representation in public schools is also correlated with the opportunities they have to attend formal and informal meetings, connect with mentors and internship opportunities, and participate in study groups. As before, the percentage minority students is only correlated with the representation of minorities in the faculty and with the representation of women students in their college.

The story is quite different for private schools. Women's representation seems to be connected to minority students' representation—also possibly the result of selective admissions. The percentage women in private schools are also strongly correlated with the availability of scholarships and the opportunity to engage in out reach activities. The representation of minorities in private schools is correlated with the percentage minority faculty in 2006, the

availability of minority engineering student organizations, and whether diversity efforts are geared toward students from low socioeconomic backgrounds.

Most of the relationships we hypothesized were correct: the majority of diversity efforts are correlated with higher representations of women and minorities. However, the effect of size and private/public status on the success of these efforts is complex. As we saw in the descriptive statistics, each factor was held by a majority of engineering colleges for the large schools but by only a minority of small and medium-sized schools. It is hard to determine whether the lack of significant results is due to the invariability in these dichotomous variables, or due to the ineffectiveness of the efforts that are in place. Large schools likely have more funds to put toward diversity efforts, but that does not mean that such efforts are more successful than those at small and medium-sized colleges. The extensiveness measures will help us parse out these relationships. The relationship between the diversity efforts and the representation of women and minorities was very clear for small schools, however: strong diversity efforts such as scholarships are correlated with higher numbers of women and minorities. Furthermore, the diversity efforts offered by public schools have more dimensions and seem to have more of an effect (at least for women) than those in private schools.

Measures of Extensiveness

We created several scale variables to assess the importance of the extensiveness of diversity programs. The bivariate correlations between these scale variables and the representation of women and minorities are presented in Table 3.

Our first measure of extensiveness, the extent of inclusiveness of different demographic groups, is uncorrelated with the representation of women and minorities in graduating cohorts. If this variable was significant, we could say that programs which cast their net wide and are inclusive of many different demographic groups appear to be most successful at graduating diverse cohorts. On the other hand, if this variable was negative and significantly related to women and minority representation, we would say that it is most important for programs to selectively target only a few student groups. However, it appears that a diversity program's level of specificity does not matter to their success.

The extent of career-oriented resources shows strong and positive correlations with women's representation in the model with all schools, and with the representation of minority students at small schools and private institutions. This scale variable measures the extensiveness of a program's investment in scholarships, internships, outreach

activities, and mentoring—all factors that help students succeed in their majors and ease the transition to the workforce or graduate school. Each of these individual factors were significantly correlated with women and minority representation for at least some schools, but it appears that having multiple opportunities to seek career-oriented assistance is important over and above the individual factors.

Our measure for the extent of social and physical space, combining the bridge program, study groups, dedicated physical space, and formal diversity program indicators, is strongly significant and positive for both women's and minorities' representation in the model with all schools, and particularly at small schools. It is likely that small schools lack the resources and personnel for these costly diversity efforts, and schools that do have them are more likely to produce a diverse graduating class than those who do not. The measure of extent of events is similarly significant.

Surprisingly, the extent of student organizations offered is correlated with the representation of women and minority students only in private institutions. This could be the result of vastly different levels of activity, participation, and funding of these organizations at different schools. Since this extensiveness measure does not differ markedly between private and public schools, it seems that the very existence of these organizations at private institutions matters to students. In public schools, the mere existence of student organizations directed toward minorities appears not facilitate increased diversity alone.

In order to tally the full extensiveness of the diversity efforts at each school, we created an index-type variable that summed (linearly) the values of all five extensiveness indicators. This measure, ranging from zero to 17, is strongly significant and positive for women and minority representation in the model with all schools, and particularly among the small schools and private schools.

Our final measure, and in many ways an important measure of success of diversity efforts, is the dichotomous indicator of whether or not schools have formal diversity programs. Interestingly, diversity programs are strongly correlated with high representations of women students, but uncorrelated with minority students at all sizes of schools.

DISCUSSION

Using detailed data collected for 63 schools, we found the correlation between over 30 measures of diversity efforts and the foundational measure of diversity effort success: the representation of women and minorities among the schools' graduating cohorts. We discovered that the majority of diversity efforts are significantly correlated with

diversity among graduates in schools of certain sizes and private/public status, and that the extensiveness of programs are themselves important covariates with diversity.

Most fundamentally, we have illustrated that investing in diversity efforts appears to be highly correlated with the representation of women and minorities. This finding helps to support something that is “qualitatively” claimed by advocates and administrators of diversity programs: these investments—however small or large—appear to be working. We believe it is important to reiterate this finding statistically with a sample of diversity programs from across the United States in order to provide quantitative confirmation of the success of these diversity investments. An important next step is to quantify the marginal contribution of another level of investment in diversity programs. Information of this type would allow administrators to determine an “optimal” level of investment, defined to be where the marginal benefits of the additional investment are equal to the investment itself.

Beyond this, we found other interesting patterns in the apparent effectiveness of these diversity efforts. First, different efforts matter more for women than for minorities. We found many more significant correlations between individual efforts and the representation of women than between these efforts and the representation of minorities. This may be the result of broader geographic factors on the representation of minorities, but it also suggests that the efforts currently in place are better tailored to promoting women’s representation in engineering. We may need different approaches to promote the representation of minorities.

Second, it appears that increases in diversity efforts would make the most difference at *small* engineering colleges. These same colleges are also likely to have the least amount of resources available for diversity efforts. Since having less than 150 graduates a year could mean only 20 women in a given cohort, the effects of tokenism and isolation could be most pressing in these settings. Even small efforts such as a few informal events or the facilitation of study groups could make a difference for these students.

Third, the diversity efforts in private schools lag those in public schools on nearly every measure, and we see a strong need for those efforts in the correlations with the extensiveness measures. The payoff for investments in diversity efforts seems to be higher at private institutions than public ones.

Finally, this study allows us to point out which efforts appear to be the most effective investments for engineering colleges. We find that the efforts most correlated with the representation of women and minorities are the career-oriented resources: scholarships, links to internships, and mentorship programs. These provide students with opportunities to focus on their academic work, develop their engineering skills and get a sense for the

profession before they graduate. Events hosted by the college for women and minorities are also strongly correlated with the representation of women and minorities. Formal events, such as a speaker series or a catered dinner, allow colleges the opportunity to provide women and minorities with encouragement and a chance to network. Informal events, such as potlucks or mixers, allow the students to connect with one another and expand their support systems. These investments, as we have shown, are strongly correlated with diversity in engineering colleges. It confirms what diversity effort administrators and advocates have long known anecdotally: these efforts *are* effective.

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Table 1: Descriptive Statistics (Means and *standard deviations*) for key variables

Extent of dedicated social and physical space	1.73	1.70	1.11	1.37	1.85	1.78	2.29	1.79	1.74	1.66	1.72	1.80
Extent of hosted events	.97	.95	.42	.77	1.15	.97	1.29	.92	1.08	.91	.80	1.00
Extent of student organizations offered	1.37	.85	1.58	.61	1.31	.88	1.29	.99	1.34	.88	1.40	.82
Measure of Extensiveness of Diversity Prog.	6.81	4.55	4.63	3.68	7.27	4.72	8.76	4.37	7.21	4.66	6.20	4.39
Has a Diversity Program?	.62	.490	.40	.50	.62	.50	.83	.38	.62	.49	.64	.49
	mean	s.d)	mean	s.d)	n	(s.d.aev)	n	(s.d.aev)	n	s.d)	n	s.d)
Ave. Percent Women in Graduating Cohort	.188	.077	.170	.079	.196	.067	.198	.047	.170	.058	.216	.099
Ave. Percent Minorities in Graduating Cohort	.255	.206	.229	.206	.217	.171	.339	.221	.243	.199	.256	.207
2001 Percent Women Faculty	.09	.05	.09	.05	.08	.03	.10	.04	.09	.03	.10	.06
2006 Percent Women Faculty	.12	.06	.12	.06	.12	.06	.13	.05	.11	.05	.14	.07
% Chg in rep of women in faculty, 01 to 06	.48	.82	.32	.82	.59	.99	.46	.44	.35	.76	.70	.91
2001 Percent Minority Faculty	.23	.14	.26	.14	.25	.16	.19	.09	.26	.14	.19	.12
2006 Percent Minority Faculty	.32	.14	.30	.14	.33	.15	.32	.14	.33	.15	.30	.14
% Chg in rep of minorities in faculty, 01 to 06	.62	1.39	.46	1.39	.72	1.70	.68	1.34	.36	.71	1.07	2.01
Private Institution?	.39	.49	.42	.49	.35	.49	.44	.51				
Program that specifically Serves Women	.52	.50	.32	.50	.50	.51	.76	.44	.55	.50	.48	.51
Program that serves "minorities" generally	.33	.48	.16	.48	.35	.49	.53	.51	.37	.49	.28	.46
Serves African American students	.14	.35	.00	.35	.19	.40	.24	.44	.18	.39	.08	.28
Serves Hispanic students	.16	.37	.00	.37	.19	.40	.29	.47	.18	.39	.12	.33
Serves Asian Students	.02	.13	.00	.13	.04	.20	.00	.00	.03	.16	.00	.00
Serves Native American Students	.14	.35	.00	.35	.23	.43	.18	.39	.21	.41	.04	.20
Serves Students with Disabilities	.05	.22	.00	.22	.08	.27	.06	.24	.05	.23	.04	.20
Serves students from lower-class SES	.10	.30	.05	.30	.08	.27	.18	.39	.13	.34	.04	.20
Serves under-prepared students	.25	.44	.05	.44	.31	.47	.41	.51	.29	.46	.20	.41
Serves international students	.08	.27	.11	.27	.04	.20	.12	.33	.08	.27	.08	.28
Offers Scholarships?	.67	.48	.58	.48	.65	.49	.82	.39	.71	.46	.60	.50
Offers Informal events/meetings?	.43	.50	.16	.50	.54	.51	.59	.51	.45	.50	.40	.50
Offers formal meetings, speakers, etc	.54	.50	.26	.50	.62	.50	.71	.47	.63	.49	.40	.50
Offers links to internships	.30	.46	.11	.46	.35	.49	.47	.51	.32	.47	.28	.46
Participates in outreach activities	.57	.50	.47	.50	.54	.51	.71	.47	.63	.48	.48	.51
Offers pre-college summer bridging programs	.41	.50	.32	.50	.50	.51	.41	.51	.47	.51	.32	.48
Facilitates study groups	.33	.48	.16	.48	.38	.50	.47	.51	.37	.49	.28	.46
Facilitates mentoring	.49	.50	.32	.50	.46	.51	.76	.44	.50	.51	.48	.51
Has a dedicated space in which to meet	.25	.42	.21	.44	.19	.40	.41	.51	.21	.41	.32	.48
Has a dedicated residence hall floor	.11	.32	.00	.32	.15	.37	.18	.39	.08	.27	.16	.37
Has chapters of minority engineering orgs	.60	.49	.63	.50	.58	.50	.65	.49	.61	.50	.60	.50
Has chapter of women engineering org	.76	.43	.95	.43	.73	.45	.65	.49	.74	.45	.80	.41
Number of Staff dedicated to diversity efforts	1.22	2.41	.74	2.41	.73	2.01	2.59	3.37	1.11	2.37	1.40	2.52
Extent of inclusiveness of racial/ethnic groups	.71	1.38	.05	.23	.96	1.68	1.12	1.45	.89	1.57	.44	1.00
Extent of Career-Oriented Resources	2.03	1.56	1.47	1.35	2.00	1.67	2.76	1.39	2.16	1.53	1.84	1.60

Table 2: Bivariate Correlations between Percent Women and Percent Minority Graduates and Characteristics of Engineering School and Diversity Program

	ALL SCHOOLS		SMALL SCHOOLS (Graduates < 150)		MEDIUM SCHOOLS (150 < Graduates < 400)		LARGE SCHOOLS (Graduates > 400)		PUBLIC SCHOOLS		PRIVATE SCHOOLS	
	% women	% minority	% women	% minority	% women	% minority	% women	% minority	% women	% minority	% women	% minority
% women		.427**	---	.477*	---	.398*	---	.470*	---	.595**	---	.341⁺
% minority	.427**	---	.477*	---	.398*	---	.470*	---	.595**	---	.341⁺	---
2001%FacWom	.184	.057	.226	-.215	.017	-.002	.377	.459⁺	.265	.148	.123	.053
2001%FacMin	.044	.235⁺	.179	.524*	-.135	.262	.292	.095	.200	.307⁺	.055	.013
2006%FacWom	.210⁺	.108	.127	.006	.256	-.028	.512*	.434⁺	.333*	.241	.046	.002
2006%FacMin	.190	.436**	.301	.380⁺	-.025	.405*	.319	.609**	.351*	.411*	.130	.526**
% Chg in rep of Women in faculty from 01 to 06	.105	.120	-.013	.383	.177	.021	.101	.069	.287⁺	.187	-.185	-.057
% Chg in rep of Minorities in faculty from 01 to 06	.207	-.014	.179	-.130	.251	-.262	.225	.442⁺	.053	-.222	.178	.131
Private Institution?	.287*	.034	.231	-.299	.528**	.146	.094	.182	---	---	---	---
Specifically Serves Women?	.334**	.149	.461*	.566*	.101	-.171	.488*	-.180	.438**	.185	.327	.103
Serves "minorities" generally	.327**	.219⁺	.474*	.369	.196	-.058	.332	.237	.420**	.172	.361⁺	.304
Serves African American students	.077	.046	.	.	.112	.146	-.074	-.184	.188	.012	.076	.139
Serves Hispanic students	.092	.138	.	.	.112	.146	-.008	.027	.188	.012	.073	.371⁺
Serves Asian Students	-.015	-.111	.	.	-.049	-.170	.	.	.027	-.142	.	.
Serves Native American Students	.029	-.012	.	.	.024	.034	-.148	-.156	.141	-.060	.099	.163
Serves Students with Disabilities	.154	.096	.	.	.350⁺	.271	-.129	-.108	.057	.160	.303	-.006
Serves students from low SES	.114	.130	.222	.100	.063	-.078	.014	.211	.324*	.025	-.011	.436*
Serves under-prepared students	.195	.172	.222	.100	.211	.035	.078	.214	.339*	.121	.161	.271
Serves international students	.188	.186	.420⁺	.204	-.044	.040	.030	.241	.221	.053	.188	.380⁺
Offers Scholarships?	.322*	.202	.573**	.641**	-.102	-.300	.568*	.193	.247	.127	.500*	.315
Offers Informal events	.254*	.079	.498*	.374	.084	-.156	.036	-.049	.352*	.118	.242	.026
Offers Formal events	.265*	.133	.608**	.602**	-.084	-.129	.023	-.203	.498**	.224	.242	.026
Offers links to internships	.294*	.242⁺	.378	.478*	.234	-.212	.297	.469⁺	.383*	.145	.290	.393⁺
Participates in outreach	.239⁺	.161	.134	.256	.272	.020	.422⁺	.081	.153	.177	.429*	.152
Offers pre-college summer bridging programs	.120	.099	.103	.489**	.023	-.232	.307	.143	.135	.037	.231	.211
Facilitates study groups	.146	.066	.454*	.463*	-.136	-.276	.013	.004	.368*	.016	.026	.153
Offers a mentorship program, or facilitates mentoring	.331**	.206	.461*	.566*	.112	-.211	.460⁺	.081	.422**	.168	.319	.265
Do they have a dedicated space in which to meet?	.308**	.223⁺	.618**	.430⁺	-.050	-.284	.347	.384	.265	.101	.318	.377⁺
Do they have a dedicated residence Hall floor?	-.083	-.074	.	.	-.215	-.279	-.198	-.016	-.073	-.184	-.158	.035

Has chapters of minority engring orgs (e.g. soc of Black engineers)	.205	.242 ⁺	.275	.270	.274	.196	-.028	.276	-.110	.057	.521**	.509**
Has chapter of Society of Women Engineers (SWE)	-.052	.008	.282	.224	-.167	-.158	-.028	.276	-.325*	-.109	.166	.185
Number of Staff dedicated to diversity efforts	.197	.176	.482*	.253	-.038	-.143	.294	.175	.182	.104	.207	.274

Notes: + p < .10 * p < .05 ** p < .01 (two-tailed test)

Table 3: Bivariate Correlation between Percent Women and Percent Minority Graduates and Extensiveness of Diversity Program

	ALL SCHOOLS		SMALL SCHOOLS (Graduates < 150)		MEDIUM SCHOOLS (150 < Graduates < 400)		LARGE SCHOOLS (Graduates > 400)		PUBLIC SCHOOLS		PRIVATE SCHOOLS	
	% women	% minority	% women	% minority	% women	% minority	% women	% minority	% women	% minority	% women	% minority
% women	---	.427***	---	.477*	---	.398*	---	.470*	---	.595***	---	.341 ⁺
% minority	.427***	---	.477*	---	.398*	---	.470*	---	.595***	---	.341 ⁺	---
Extent of Inclusiveness of racial/ethnic groups	.112	.090	.222	.100	.113	.068	-.038	-.014	.233	.011	.131	.302
Extent of Career-Oriented Resources	.368**	.251*	.518*	.651**	.155	-.207	.557*	.280	.377*	.193	.478*	.344 ⁺
Extent of dedicated social and physical space	.272*	.161	.577**	.590**	-.028	-.254	.272	.156	.344*	.088	.254	.261
Extent of hosted events	.272*	.111	.601**	.536*	.001	-.148	.032	-.131	.457***	.184	.242	.026
Extent of student organizations offered	.094	.146	.331	.305	.071	.031	-.028	.276	-.227	-.023	.402*	.404*
Measure of Extensiveness of Diversity Prog.	.337**	.224 ⁺	.598**	.626**	.098	-.169	.277	.184	.375*	.131	.438*	.385*
Has a Diversity Program?	.441***	.182	.587**	.284	.212	.040	.539*	.021	.466**	.250	.491*	.212

Notes: + p < .10 * p < .05 ** p < .01 (two-tailed test)