

THE ENGINEERING CONCEPTS INSTITUTE: THE FOUNDATION OF A COMPREHENSIVE MINORITY STUDENT DEVELOPMENT PROGRAM AT THE FAMU-FSU COLLEGE OF ENGINEERING

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Abstract $\frac{3}{4}$ Bridge programs have sought to improve the transition and retention of minority students for over two decades. Even those that have been successful have faced a difficult challenge due to the cost-intensive nature of such programs. The purpose of this paper is to recount the success of one such bridge program, the Engineering Concepts Institute, and the rest of the comprehensive minority student development that follows it, serving students of Florida A&M University matriculating to the Florida A&M University—Florida State University College of Engineering. A significant improvement in six-year graduation rates is observed for cohorts from 1987-1992 (χ^2 , $\alpha=0.05$). It is hoped that the strategic partnership between Ohland and Zhang, who are using a longitudinal database compiled by the SUCCEED Coalition to study engineering programs, and Foreman and Haynes, the program's coordinators, will yield the evidence needed to seek alternative funding sources from industrial sponsors, foundations, and even participating students and their parents. This evidence is critical when budget cuts threaten to shut down this valuable program.

Index Terms $\frac{3}{4}$ Bridge programs, minority programs, minority retention, minority student development.

INTRODUCTION

The Minority Engineering Programs office of the Florida A&M University—Florida State University (FAMU-FSU) College of Engineering introduced in summer 1987 a bridge program for students admitted to FAMU in an engineering discipline (the College itself first graduated students for the first time in 1985). This initial program, called the Engineering Concepts Institute (ECI), is an intensive, six-week program that encourages an early awareness of engineering fundamentals, including coursework in calculus, physics, and chemistry, design projects, special cultural and social seminars, field trips, and computer skill workshops. The participants also have the opportunity to meet practicing professional engineers. In structured programming from 8-4

every day. There is a “selection process,” but it is primarily aimed at identifying the needs of each participant, rather than to exclude students from the program. As a result, the program population is considered to be self-selected.

In Fall 1990, the Cooperative Academic Resources for Excellence (CARE) program was added to continue the work of ECI in fostering minority student development. All ECI students participate in CARE, in which they enroll in Introduction to Engineering (a standard course offering) and receive training in time management, cultural awareness, critical thinking, career planning, and test-taking and study skills. In the CARE program, students work collaboratively under the supervision of a facilitator who is well-versed in the subject of matter engineering fundamentals. Facilitators do not act as simple tutors but challenge the student to master the engineering subjects. Facilitators are specially trained in the mechanics of increasing a student's engineering awareness and powers of observation.

After students matriculate to the College of Engineering, they can choose to participate in the Departmental Learning Center (DLC) program. The same model of facilitated active and cooperative learning used in CARE is adopted at this level, but because students have now affiliated with engineering departments, the DLC program focuses even less on content and more on skills and processes. Facilitators are required to perform pre and post assessment of the performance of students.

EXPERIMENTAL / CONTROL GROUP DEFINITION

Since the MEP programs discussed are open to all FAMU students matriculating in engineering, students participate in the program through a process of self-selection. The control group contains all FAMU students matriculating in engineering that did not choose to participate in the MEP programs. It should be noted that FAMU is identified as one of the Historically Black Colleges and Universities (HBCUs), and, for statistical purposes, it can be assumed that the student population is made up entirely of black students.

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DATA COLLECTION

Cohort, graduation, and retention data for the experimental group (labeled MEP) and the control group (labeled Non-

MEP) were obtained from the SUCCEED longitudinal database.[2] SAS frequency procedures were used to extract figures for six-year graduation (Table 1). Graduation figures only include students graduated in an engineering discipline.

TABLE 1
6-YEAR GRADUATION DATA, EXPERIMENTAL AND CONTROL GROUPS, COHORTS 1987-1994

Cohort	MEP/Non-MEP	Graduated	Not Graduated
1987	MEP	5 (4.01)	6 (6.98)
	Non-MEP	33 (33.98)	60 (59.02)
1988	MEP	8 (7.78)	10 (10.22)
	Non-MEP	46 (46.22)	61 (60.78)
1989	MEP	14 (8.22)	6 (11.78)
	Non-MEP	46 (51.78)	80 (74.22)
1990	MEP	11 (10.32)	17 (17.68)
	Non-MEP	62 (62.68)	108 (107.32)
1991	MEP	14 (11.51)	11 (13.49)
	Non-MEP	73 (75.49)	91 (88.51)
1992	MEP	11 (8.08)	5 (7.92)
	Non-MEP	88 (90.92)	92 (89.08)
1993	MEP	17 (12.02)	11 (15.98)
	Non-MEP	62 (66.98)	94 (89.02)
Total: 1987—1993	MEP	80 (62.64)	66 (83.36)
	Non-MEP	410 (427.36)	586 (568.64)

Note: numbers in () are expected cell counts under the independence assumption.

DATA ANALYSIS

Table 2 cross-classifies FAMU-FSU engineering students matriculated from FAMU according to whether they participated in the MEP programs described earlier and whether they graduate after 6 years of study. For example, for 1987 cohort students, 5 out of 11 students in the MEP program had graduated after 6 years of study and 6 out of 11 had not graduated, whereas for Non-MEP students, 33 out of 93 had graduated and 60 out of 93 had not graduated. First, we must establish whether an association exists between MEP and graduation. This determines whether the MEP program has any effect on 6-year graduation rate, or whether the likelihood of graduation is independent participation in the MEP program. To answer this question, we use the Pearson Chi-Squared statistic to test independence.

The common approach to investigate statistical dependence has been the Chi-Squared test of independence, proposed by Karl Pearson in 1900.[1, p. 28] The data for each cohort were analyzed using the Pearson Chi-Squared statistic to test the null hypothesis H_0 : graduation is independent of whether students are in MEP program. The statistic compares the observed cell counts to the cell counts expected if there were no dependence. The expected cell counts are shown in the table alongside the actual data. Greater differences between the expected and observed cell counts produce larger X^2 values and stronger evidence against H_0 , and that dependence is likely. The SAS Chi-Squared procedure yields the Chi-Squared statistic, the number of degrees of freedom (df), and the p-value (probability of observing the given data where no dependence exists) for each cohort, and for all the cohorts combined. These are shown in Table 2.

TABLE 2:
PEARSON CHI-SQUARED TEST FOR 6-YEAR GRADUATION IN ENGINEERING

Cohort	Chi-Square	df	p-value (* = significant at $\alpha=.05$ level)
1987	0.4217	1	0.5161
1988	0.0133	1	0.9083
1989	7.9981	1	0.0047*
1990	0.0819	1	0.7748
1991	1.1524	1	0.2830
1992	2.3187	1	0.1278
1993	4.2610	1	0.0390*
1987-1993	9.6565	1	0.0019*

For the 6-year graduation, based on the SAS results, we are 95% confident that there is dependence between MEP program and graduation for the 1989 and 1993 cohort ($p=0.0047$, $p=0.0390$ respectively), and the overall 6-year graduation is strongly associated with MEP program ($p=0.0019$). The Chi-Squared statistic does not tell us how are they associated, however. We still need to investigate whether MEP increases or decreases a student's chances of graduation, and by how much. Those questions cannot be answered with the Chi-Squared approach, so we turn to the odds-ratio approach.

The odds-ratio approach is a fundamental method for studying categorical data such as these. With this approach, one first calculate the odds of success instead of failure for one group and the odds of success instead of failure for the other group, then take the ratio of the two sets of odds.[1, p. 22] Since an odds ratio equal to 1 means that the two groups are equally likely to graduate, then for the odds ratio to be statistically significant, the confidence interval must not contain the value of 1.

For six-year graduation, a three-way 2x2x7 contingency table was constructed with 2 rows (MEP and Non-MEP), 2 columns (graduated and not graduated) and 7 layers (cohort 1987—1993, see table 3). The conditional odds ratio and the 95% confidence interval for each cohort listed in table 3 were taken from SAS output. For two cohorts (1989, 1993), the odds ratios were statistically significant at the $\alpha=.05$ level. This significance permits us to say that, for the 1989 cohort, the odds of graduation of students in the MEP group was over 4 times the odds of graduation for those in the

Non-MEP group. Because of the relatively small number of observations, we do not have enough power to achieve statistically significant values of the odds ratio for some of the cohorts, although, as we can see, some are well over 1. If we can establish that the association for each cohort was in the same direction, we can then superpose the individual cohorts, combining the information in the partial table to get a single summary measure of association for the two groups. To test if there is homogeneous association for the conditional odds ratios and to determine the overall odds ratio for the two groups, we use the Cochran-Mantel-Haenszel method.

The Cochran-Mantel-Haenszel method is commonly used to test homogeneity of association for three-way tables. The CMH statistic combines information across partial tables. When the true association is similar in each partial table, this test is more powerful than a separate test within each table.[1, p. 62]

For the six-year graduation data, with the SAS CMH procedure, we get the Breslow-Day Test for homogeneity of the odds ratio to be $X^2 = 5.5999$, with $df = 6$, and $p\text{-value} = 0.4695$. We have enough evidence to conclude that the odds ratios are homogeneous—in this case a high $p\text{-value}$ is desirable, meaning that we cannot reject the homogeneity hypothesis). Since we conclude that the odds ratios are homogeneous, we are permitted to compute the collective odds ratio for all cohorts combined, which shows a common odds ratio of 1.73. This means that the students who participate in the MEP programs are 73% more likely to graduate than are students who do not participate.

TABLE 3
ODDS RATIO, MEP VS. NON-MEP BY COHORT, 6-YEAR GRADUATION

Cohort	MEP status	Six-year graduation		Odds Ratio	95% CI
		Graduated	Not Graduated		
1987	MEP	5	6	1.5152	0.4295, 5.3444
	Non-MEP	33	60		
1988	MEP	8	10	1.0609	0.3882, 2.8993
	Non-MEP	46	61		
1989	MEP	14	6	4.0580*	1.4592, 11.2853
	Non-MEP	46	80		
1990	MEP	11	17	1.1271	0.4960, 2.5597
	Non-MEP	62	108		
1991	MEP	14	11	1.5866	0.6797, 3.7031
	Non-MEP	73	91		
1992	MEP	11	5	2.3000	0.7681, 6.8874
	Non-MEP	88	92		
1993	MEP	17	11	2.3431*	1.0285, 5.3382
	Non-MEP	62	94		
total	MEP	80	66	1.7324*	1.2215, 2.4572
	Non-MEP	410	586		

(* = significant at $\alpha=.05$ level)

DISCUSSION

We are encouraged that the statistics bear out the significance of the observed improvement in graduation rate of students participating in MEP programs (55%) compared to the graduation rate of students who do not participate (41%). While graduation rate improvement of 14% is good, use of the odds-ratio approach allows us to make the more dramatic statement that a student is 73% more likely to graduate in engineering if they participate in the Minority Engineering Programs. The results are somewhat confounded by the self-selection process—it might be argued that only those who are more likely to succeed in engineering chose to participate. The remedy for this is to compare the experimental and control groups on a common baseline such as SAT scores or high school grades, but, unfortunately, that data was not available at the writing of this paper.

SUGGESTIONS FOR FURTHER WORK

The results presented here suggest further study of the programs at hand. Clearly, when baseline data are available, it would be prudent for the study to demonstrate that the experimental group is not biased to succeed. It would also be of interest to discover if there is a concomitant improvement in time-to-graduation for the MEP participants. Expanding the study to analyze the retention of more recent cohorts (that have not yet had sufficient time to graduate) would be of interest. Finally, the unique arrangement of the FAMU-FSU College of Engineering presents an intriguing opportunity to study the success of engineering students from two distinct populations—students who matriculated at FAMU and those who matriculated at FSU.

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