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ABSTRACT

This study examined whether female college freshmen have higher first-year retention rates when a greater percentage of their classes are taught by female faculty, especially students in science, math, and computer science (SMC) courses. Data from the admissions, course, and student files at Binghamton University (New York) were analyzed over a 4-year period (1990-1993). Analysis using logit estimation was applied to three samples of students: all students, both men and women (N=6873); all students who took at least one SMC course (N=6381); and all students who took more than the sample average of their credits in SMC courses (N=3615). No role model effects were found when all courses taken by all female students were analyzed. However, a significant positive relationship was found between retention and the percentage of science, mathematics, and computer science courses taken by female students that were taught by women. Implications for gender-based affirmative action hiring programs are discussed. (Contains 26 references.) (DB)

Female Role Models: The Effect of Gender Composition of Faculty on Student Retention

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58

Abstract

The gender composition of faculty is an important issue on many campuses. Substantial efforts are taken by many colleges to hire a diverse faculty where women are equitably represented. Several papers suggest that female faculty can act as role models for female students. This issue is particularly emphasized in science and engineering programs. However, empirical research finds mixed support for this hypothesis. We provide a new test of this issue by examining whether female students have higher first-year retention rates when a greater percentage of their classes are taught by female faculty. The results show a positive relationship between retention of female students and the percentage of their science and mathematics classes taught by female faculty. Thus this study provides support for gender-based affirmative action programs for hiring.

Introduction

Student retention is the subject of a vast number of articles. Many of these efforts attempt to determine what factors lead to students' persistence. Institutional characteristics, such as whether the school is public or private, the cost of attending the institution, and student services are found to be important determinants of retention rates. Other important factors include student ability and high school quality, measured by high school GPA, SAT scores, and academic rating of the high school. In addition, individual characteristics such as race, gender, socioeconomic status, motivation, aspiration, financial factors, and student involvement are among the many factors that determine the likelihood of retention.[1]

Many colleges are also concerned with the gender composition of their faculty. Colleges often set aside special funds to encourage departments to offer positions to women. There are several reasons to create and maintain a diverse faculty. Among the issues addressed in previous research are opportunities for formal and informal interaction between female students and faculty, and the availability of potential role models.

This paper links the availability of female faculty role models with student retention. Measuring the availability of potential role models is often an approximation. For example, a researcher can measure the percentage of female faculty in an entire university. Alternatively faculty composition within departments may be considered a measure of available role models. A third alternative is to examine the faculty composition of courses actually taken by students. Each of these three measures can be applied to students as well as faculty. Students who are succeeding in a program can be role models to other students. This may be particularly true for women in nontraditional majors such as the sciences and

engineering.

While faculty composition on a university-wide basis is an important issue, there can be substantial variation in faculty composition between departments. The composition of the nursing faculty is unlikely to have much influence on students in an engineering department. Examining faculty composition at the department level may also be too broad. Simply because a department has a number of female faculty may not be important unless students interact with those faculty members. We look at the faculty composition of courses actually taken by the student during his or her freshman year. This ensures some degree of access to the faculty member by the student. The emphasis on faculty composition in classes taken by the student differentiates this study from previous papers.[2]

Also, given that substantial effort is placed on attracting more women to science and engineering majors, this issue is particularly important for these departments. Affirmative action programs that encourage hiring female faculty in science, mathematics, and engineering (SME) departments often claim that an increase in female faculty will attract more women into these majors. Canes and Rosen (1995) discuss programs at Princeton, Dartmouth, and Yale that encourage hiring female faculty in SME departments as a means to increase the number of female students in these majors. In addition to attracting students to SME majors, efforts need to be undertaken to retain female students in SME majors. For example Ott (1978) finds that retention rates for female engineering students are lower than male engineering students.

We use data from Binghamton University to analyze the likelihood of students being retained for their second year. No role model effects are found when considering the gender

composition of faculty for all courses taken by female students. However, a significantly positive role model effect is found for women in science, mathematics, and computer science (SMC) courses. Also, the greater the percentage of credits taken in SMC courses, the stronger the positive relationship.[3] We do not find a relationship between female faculty and retention for male students. Thus this study provides support for affirmative action programs that support the hiring of female faculty in SMC departments, although the test is limited to faculty that teach classes taken by freshmen students.

Role Models in Higher Education

Many studies attempt to determine whether female students find role models to be important and if role models have a positive effect on student performance.[4] Research methodology and results vary considerably among the articles. One strategy is to survey students to gain an understanding of their behavior. For example Erkut and Mokros (1984) survey students in several colleges and find that female students do not seek out female faculty as role models. Hackett, Esposito, and O'Halloran (1989) find that gender role models are not strong predictors of the nontradionality of career choices. However, Gilbert (1985) reports that female students rate role models as being more important than do male students. Betz and Fitzgerald (1987) find that role models are important in determining career choices, particularly in the sciences. Basow and Howe (1980) conclude from a survey of college students that female role models are important to female students in making career decisions. Others have argued that the ability of individuals to act as role models may be limited in many institutions. For example, Verdugo (1995) argues that Hispanic faculty are unlikely to be seen as role models by Hispanic students. Verdugo claims that individuals

must have "positions of status and power within and outside the institution" to be role models. Hispanic faculty are not as likely to be tenured as white faculty, tend to be relegated to committees that deal with minority issues, and tend to be held in lower esteem by other faculty members. Therefore, Hispanic faculty may not have the status and power required to be role models. The validity of these arguments requires further testing. It is unclear that faculty need to be tenured or full professors to be seen as role models by students. It is even less likely that students care about committee assignments.

Researchers also address these issues using a variety of alternative tests. Fox (1974) examines several universities and finds a positive correlation between the number of female faculty and the number of female students using broad academic classifications. The April 1995 issue of the Industrial and Labor Relations Review is dedicated to role models in education. Canes and Rosen (1995) examine the relationship between the gender composition of a department's faculty and the likelihood of female students selecting that major. They concentrate on science and engineering departments and find no significant relationship between faculty composition and the share of female majors in a department. Solnick (1995) compares changes in majors between entrance and graduation in single sex colleges with all female students, to changes in majors in coeducational schools; thus she emphasizes the role of student composition. She finds that female students are much more likely to shift towards "male dominated" majors in single sex colleges than in coeducational colleges. Single sex colleges may provide the support that encourages women to enter nontraditional fields. Rothstein (1993 and 1995) considers the faculty gender composition of the university. She finds a positive relationship between the percentage of faculty that are female in the

undergraduate institution and the likelihood of female students obtaining an advanced degree (master's, J.D., M.D., or Ph.D.). However, the percentage of female faculty in the institution is found to have no effect on attainment of a bachelor's degree.

Few studies link the issues of role models and retention. Previous studies find that students who are better able to socially integrate are more likely to remain in college. For example, Pascarella and Terenzini (1977 and 1979) find that informal interaction between faculty and students is a significant factor in determining retention. Astin (1975) finds that blacks have a much higher retention rate in colleges where a high percentage of the students are black. Astin (1993) finds that women who attend women's colleges have higher graduation rates, and the percentage of women on the faculty at coed institutions is positively associated with students' satisfaction with faculty.

Data

The data are derived from the admissions, course, and student files at Binghamton University.[5] Binghamton University is one of four university centers in the State University of New York system. Retention rates at Binghamton are well above the national average and the average for the other university centers (Buffalo, Albany, and Stony Brook). The one year retention rate for first-time freshmen is 93 percent and 77 percent of first-time freshmen graduate within four years.

We examine students and faculty over a four year period (1990-1993) to determine if female students are more likely to return for their sophomore year if a larger percentage of their classes were taught by women during their freshmen year. Concentrating on retention in the early stages of the student's college career has its advantages and disadvantages.

Attrition rates are at their highest at this point in time, making it important to consider first year retention rates. On the downside, classes taken during a single year may not be indicative of a student's exposure to role models.

Our sample is composed of matriculated students who entered the University in a fall semester and were registered as full-time (12 or more credits) in their first semester. We consider a student to be retained if he or she registers for classes in their second year, regardless of whether they remain full-time. This is consistent with the official measure of retention used by the University.[6] Faculty composition can be measured in a variety of ways. We define percent female faculty as the percentage of credit hours taken from female faculty:

$$\% \ Female\ faculty_i = \frac{\sum_{j=1}^{N} Female_{ij} * Credits_{ij}}{\sum_{j=1}^{N} Credits_{ij}} \qquad (1)$$

where female is a dummy variable equalling one if the course is taught by a women, credits denotes the number of credit hours assigned to the course, i indicates individuals, and j the courses taken by individual i.

This measure of percent female faculty only considers the primary section of a course and does not include secondary sections taught by teaching and lab assistants. Other possibilities include simply taking the percentage of courses taught by female faculty. This would imply that merely being exposed to the role model is more important than the amount of class time spent with the individual. It can be argued that time spent outside of the classroom on a course and time spent with faculty are correlated with credit hours, thus we

weight the class by the number of credits hours. Alternatively, secondary sections could be included in the analysis by using contact hours to weight sections instead of credit hours. While previous research emphasizes the role of faculty as role models, it is conceivable that teaching and lab assistants may also be role models. This is a possible avenue for future research.

Typically GPA is included as the measure of academic standing. Although this is an important variable, it suffers from a major drawback. The difficulty of a student's course load varies substantially across the University. Students taking easier courses may have higher GPAs than students taking difficult course loads. Thus, not all students with relatively high GPAs are necessarily good students, nor are all students with relatively low GPAs bad students. In fact, the student taking a hard course load may be the more dedicated student. We create an alternative variable to measure student performance defined as the student's GPA divided by a measure of the difficulty of the student's course load. Maloney and McCormick (1993) measure course load difficulty as the average grade for all students in courses taken by a given student:

$$Difficulty_i = \frac{\sum_{j=1}^{N} [Credits_{ij} * \sum_{k=1}^{L} \frac{Grade_{kj}}{L}]}{\sum_{j=1}^{N} Credits_{ij}} \quad (2)$$

where N = the number of courses taken by student i in year t, L = the number of students taking course j in year t, credits = the number of credits for course j, and grade = the grade of student k in course j. We then take the ratio of the student's GPA divided by the measure of course difficulty to get an adjusted measure of student performance. The ratio equals one

if the student's grades equal the average grade for all students in his or her classes. Students that perform better than other students in their classes have a ratio greater than one, while those who perform worse have a ratio less than one.

Table 1 contains variable means reported separately based on student gender and whether the student is retained. Over 93 percent of men and 92 percent of women return for their sophomore year. The GPAs of retained students are higher than the GPAs of students who do not return, with the differential being greater for men than women. Difficulty is a measure of the difficulty of the student's course load. Retained students and students who did not return took similar course loads. SAT scores, high school rank, and percent female faculty are also similar for retained and nonreturning students. Differences also exist between men and women. GPA, ease of course load, high school rank, and percent female faculty are all significantly greater for women, while men have higher SAT scores.

Table 1

Variable Means

	Men		Women	
	Retained	Not retained	Retained	Not retained
Race/ethnic background				
White	0.71	0.65	0.66	0.66
Black	0.04	0.07	0.08	0.05
Hispanic	0.05	0.09	0.06	0.10
Asian	0.13	0.12	0.13	0.12
School				

Arts & Sciences	0.84	0.85	0.87	0.89
Management	0.12	0.08	0.09	0.05
Nursing	0.001	0.00	0.03	0.04
Engineering	0.03	0.07	0.01	0.01
Other characteristics				
GPA	2.97	2.21	3.01	2.66
Difficulty	2.89	2.80	2.94	2.91
SAT	1161	1132	1096	1090
HS Rank	88.4	86.5	89.7	88.6
% Female Faculty	22.2	21.6	28.5	27.7
Number of obs	2,716	195	3,652	310

Note. - White, Black, Hispanic, and Asian are proportions denoting race/ethnic background. Approximately 7 percent of the sample is divided among various other race/ethnic categories. Arts & Sciences, Management, Nursing, and Engineering are proportions denoting school. GPA and difficulty are measured on a four point scale. High school rank is a percentile, and percent female faculty is the percentage of credits taken by the student that are taught by female faculty.

We attempt to establish a link between the percent female faculty and student retention. The samples are divided into three groups based on the percent of the student's credit hours taken with female faculty. As reported in Table 2, there is no clear relationship between percent female faculty and retention rates for men or women. Duncan's multiple

range test is used to test for significant differences between retention rates for each group (Duncan, 1975). No significant differences are found for men or women. Of course, other factors are not being held constant in this table. We also present retention rates for SMC students. For the purpose of this table, a student is classified as an SMC student if at least one-third of his or her credits are in SMC classes. Also, percent female faculty is computed only for SMC courses taken by the student. No significant differences are found between groups of men. However, a significant positive relationship is found for this group of women. Retention rates increase as the percentage of credits taken from female faculty increases.

Table 2

One-Year Retention Rates by Percent Female Faculty

	Men		Women	
% Female Faculty	N	Retention	N	Retention
		All students		
0 - 15%	1270	93.5%	1105	92.0%
>15 - 30	863	93.5	1256	92.6
>30	778	92.8	1601	92.0
		Science, Mathematics, and Computer Science Students		
0 - 15%	945	92.4%	871	89.0%
>15 - 30	349	93.4	506	91.1
>30	351	92.6	593	94.0

Methodology

We examine how the gender composition of faculty in classes taken by students influences the likelihood of being retained. The dependent variable is dichotomous, equalling one if the individual is retained and zero otherwise. Since the dependent variable is not continuous, ordinary least squares estimates are biased and we must use maximum likelihood techniques (see Maddala, 1983). Logit estimation is performed with the following specification:

$$Pr(staying)_{it} = \beta_1 \%Female_{it} + \beta_2 X_{it} + \epsilon_{it} \quad (3)$$

where i denotes individuals and t equals 1990, 1991, 1992, or 1993. Percent female is the percentage of their credit hours that are taught by women during the school year, X is a vector of independent variables, and i denotes individuals. The independent variables include dummy variables for the schools within Binghamton University and race/ethnic background of the student. The schools include Engineering and Applied Science, Management, Nursing, and Arts and Sciences.[7] Again, it is important to note that the School of Engineering and Applied Science only accepts freshmen into its Computer Science major. There are no engineering majors in our sample and the only courses taken by freshmen in the School of Engineering and Applied Science are computer science classes. The current academic standing of the student is proxied by the student's GPA adjusted for the difficulty of course load.

We also included SAT scores and high school rank in the logit specification to control for individual ability, however they were consistently insignificant and were removed. Previous studies examining students across universities include many institutional factors in

their analysis. Institutional factors are not relevant for our study since we are dealing with a single university.

The above specification is estimated for three samples of men and women. The first sample includes all men and women.[8] From a policy perspective, the emphasis on female faculty being role models is greatest in science, mathematics, and engineering. Female students are unlikely to need faculty as role models in "female dominated" majors such as nursing. We test whether role model effects differ between the entire student population and SMC students. Science and Mathematics is one of four divisions in Harpur College of Arts and Sciences. Students usually do not declare majors in Harpur College until their sophomore or junior year, making any classification of a student as a science or mathematics student arbitrary. We examine the gender composition of faculty in SMC courses taken by a student. Adjusted GPA is also limited to SMC courses. Therefore, the second sample includes all students who took at least one SMC course. This sample concentrates on a portion of a student's course load as opposed to all courses. This may be questioned since a student taking only one of these courses will have a percent female faculty of zero or one. The third sample includes students who took more than the sample average of one-third of their credits in SMC courses. This will better limit the sample to students anticipating a major in one of these disciplines.[9]

Results

Logit results are presented in Table 3.[10] We only report coefficients for the student performance and percent female faculty variables in order to conserve space. Complete results are available upon request. Column 1 includes all individuals in the sample. Column

2 limits the sample to those students who took at least one SMC course. Column 3 is limited to SMC students, defined as those who took at least one-third of their credits in SMC courses. Coefficients from logit estimation do not provide the marginal effects of changes in independent variables. These are calculated as $\beta p(1-p)$ where β is the estimated coefficient and p is the proportion of the sample that is retained.

Table 3

Logit Results for Predicting One-Year Retention Rates

	All students (1)	∂P/∂X	SMC Courses (2)	∂P/∂X	SMC Students (3)	∂P/∂X
			Men			
Adjusted GPA	4.090 ** (.318)	.2556	2.495 ** (.239)	.1567	3.113 ** (.333)	.2121
% Fem Fac	.9293* (.495)	.0581	.0143 (.292)	.0009	-.1346 (.483)	-.0092
N	2,911		2,702		1,645	
Log likelihood	-620.5		-604.9		-378.8	
			Women			
Adjusted GPA	2.850 ** (.277)	.2056	1.129 ** (.202)	.0830	2.111 ** (.296)	.1902
% Female Fac	.2676 (.352)	.0193	.6755 ** (.235)	.0497	1.238 ** (.429)	.1115
N	3,962		3,679		1,970	
Log likelihood	-1026.8		-994.3		-560.5	

Note. - Dependent variable: 1 if the student is retained for their second year; 0 otherwise.

Standard errors are reported in parentheses. ** significant at the 5 percent level; * significant at the 10 percent level.

The results for men are provided first. Sample sizes vary depending on the conditions placed on the sample. Column 1 includes all 2,911 men in the sample. A total of 209 men did not take any SMC courses and are removed from the sample in column 2. A total of 57 percent of the initial sample took at least one-third of their credits in SMC classes in column 3. The majority of variables are insignificant. No significant difference in retention is found between race/ethnic groups. Computer science students are less likely to be retained than students in other majors. However, this differential disappears when comparing computer science students with other students taking a substantial number of SMC credits. Students who perform better are more likely to be retained.[11] Student performance is the most important factor in determining retention. A one unit increase in the ratio increases retention by 15 to 25 percentage points. A marginally significant relationship between retention and percent female faculty is found when considering all male students. No significant relationship is found when limiting the sample based on SMC courses. We attempted to examine why role model effects are found for male students. Role model effects for men appear to be focused on the fine arts and humanities divisions of Harpur College. It is possible that female faculty are role models for male students. Role models may be chosen based on individual characteristics in addition to gender. This issue needs further investigation.

The results for women are also in Table 3. Again the sample sizes vary depending on

the sample. There are 3,962 women in the initial sample. A total of 283 women are removed from the sample due to a lack of any SMC credits. A substantial percentage (50%) of women remain in the final sample. Again many coefficients are insignificantly different from zero. Black females have higher retention rates than other race/ethnic groups. Women in the School of Management have higher retention rates than women in other schools. Again, student performance is found to be the most important factor in determining retention. A one point increase in adjusted GPAs leads to an 8 to 21 percentage point increase in the likelihood of returning for the second year. The results for percent female vary depending on the sample. Percent female faculty is not found to be an important factor for the entire sample of women. However, the results show a strong positive link between the percent female faculty and retention when considering SMC courses. The larger the percentage of SMC courses taken with female faculty, the more likely female students will return for their second year. It is important to note the marginal effect is much stronger when limiting the sample to students taking at least one-third of their credits in SMC courses. Faculty composition is important in SMC courses, and it becomes more important the greater the number of credits taken in these disciplines.[12]

Conclusion

The ability of female faculty to serve as role models for female students is often used as a justification for affirmative action programs that encourage the hiring of women faculty. Previous empirical research has found mixed support for this hypothesis. Two issues may be of importance to these studies. Studies have generally looked at issues such as choice of majors, years of schooling, or labor market success. The first question that needs to be

examined is retention. The other issues, while important, rely on students staying in school. Also, previous research on female faculty looks at faculty composition within universities as a whole, or within departments. This level of aggregation makes it difficult for empirical research to find role model effects. For example, simply because a department has a number of female faculty may not be important unless students interact with those faculty members. We look at the faculty composition of courses actually taken by the student. This ensures some degree of access to this faculty member by the student.

This issue is addressed using data from Binghamton University. No role model effects are found when including all courses taken by female students. A significant positive relationship is found between retention and the percentage of science, mathematics, and computer science courses taken by female students that are taught by women. The policy implications of this study are far reaching. The positive relationship between retention of female students and the percentage of the faculty that are female provides support for programs that encourage the hiring of female faculty in specific disciplines. This would also suggest that departments may want to implement programs that encourage both formal and informal contact between female faculty and female students.

Future research can address many different issues. First, the results reported in this paper are for a single university. Replication with data from other universities that are able to include engineering students and courses would be useful. Second, a variety of additional issues can be examined. Does the gender composition of courses contribute to choosing a major? For example, women taking a higher percentage of SMC courses from women may be more likely to select an SMC major or to continue in the major once it is selected.

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Endnotes

1. For overviews, see Tinto (1975 and 1987), Pascarella and Terenzini (1980), Lenning, Beal, and Sauer (1980), and Noel, Levitz, Saluri, and Associates (1985) among many others.

2. Our original goal was to perform this test based on race/ethnic background as well as gender. There are a troublesome number of faculty observations with missing race/ethnic information. We are able to identify faculty gender for over 97 percent of classes offered during the sample period. We exclude the course from the analysis when gender is missing.

3. The School of Engineering and Applied Science only accepted freshmen students into the Computer Science program during the sample time period. Thus we are unable to include engineering students or courses in our analysis.

4. The articles mentioned in this paper are not meant to be an exhaustive listing. Rather the goal is to give the reader an idea of the types of studies that are performed. Also, the issue of role models in education is not limited to higher education. Evans (1992) and Ehrenberg, Goldhaber, and Brewer (1995) examine the issue of role models in high school. Both studies find that female students do not learn more from female teachers than male teachers.

5. These data must be kept confidential and cannot be shared with other researchers.

6. This measure does not differentiate between voluntary and involuntary leavers. The data at our disposal does not clearly differentiate between the two groups. Some people are counted as not being retained who leave due to financial or other nonacademic reasons. Female faculty may have been positive and influential role models for these people. This will lead to an understatement of the effect of female faculty on retention.

7. The School of Education and Human Development does not accept freshmen and is therefore not included in the analysis.

8. Estimation is performed separately for men and women. We estimated a single regression including both men and women. Women were significantly less likely to be retained than men. No role model effects were found for the combined sample.

9. Computer science students could easily be classified as SMC students since the Watson School of Engineering and Applied Science is a separate school within the University. However, to be consistent we classify these students based on their courses and do not automatically classify them as SMC students. We reestimated the specifications for a sample that counted all computer science students as SMC students and found similar results.

10. We keep school and race/ethnic variables in the specification despite being insignificant in many cases. The fact that these coefficients are insignificant is interesting and the coefficients on percent female faculty do not change significantly if we remove all insignificant variables from the specification.

11. We tested the unadjusted GPA and found the expected positive relationship. The choice of measure for student performance had no impact on the percent female faculty variable. We also tested specifications that excluded any measure of student performance. This may be important if role model effects result in improved classroom performance. The results for percent female faculty for both men and women were similar to those reported in this paper.

12. To provide additional support for this conclusion we estimated a specification for the entire samples of men and women that included a variable measuring the percentage of credits taken by the student in SMC courses and an interaction between this variable and percent female faculty. We found that women who take a greater percentage of their credits in SMC courses were less likely to be retained. The interaction was positive indicating a stronger role model effect the greater the percentage of credits in SMC courses.