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The Effect of Financial Support on Academic Achievement and Retention of Female Engineering Students

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ABSTRACT

While women have become well represented in some STEM (Science, Technology, Engineering, and Mathematics) fields such as biology, life science, and medical fields in recent years; they remain severely underrepresented in engineering. Among those who enter engineering, women are more likely to drop out of the major than men. Research has indicated that financial difficulty is among the top factors influencing retention of students in engineering in general, underrepresented students, and non-traditional students. Yet little research has looked the influence of financial factors on retention of women. This study examined how financial support influenced the retention and academic achievement of women in engineering.

This study focused on another type of financial support – a loan repayment award – and its influence on undergraduate women's academic achievement and completion in College of Engineering at Kansas State University. Specifically, a private organization, the E. Eugene Carter Foundation, provided an incentive for degree completion, the Carter Opportunity Award, to undergraduate women in the form of a repayment of subsidized student loans upon completion of an engineering degree. In this study, we examined whether this financial incentive of a student loan repayment awarded upon graduation influenced undergraduate women's retention and academic achievement in engineering.

This quantitative study used a pretest-posttest quantitative design. Forty sophomore women engineering students, stratified by first generation status and ethnicity, were randomly placed into the experimental group (selected to receive repayment of their subsidized student loans on completion of an engineering degree) and the control group (not selected to receive loan repayment upon completion of an engineering degree). At the beginning of the study, students in the experimental group were told that their subsidized loans incurred during their time at Kansas State University would be paid off after graduation with an engineering degree. Students in the control group were not told about the program. The initial grade point averages (GPAs), the final GPA, graduation status, and demographic information were collected from all participants. Multiple statistical methods were used including independent *t*-test, repeated-measure analysis of variance, and chi-square test.

We found that (1) while the experimental group and the control group as a whole were very similar in terms of their initial average GPAs, participants in the control group who successfully graduated with an Engineering degree had statistically significantly higher baseline GPAs than those who did not graduate; by contrast participants in the experimental group who graduated with an engineering degree had statistically similar initial average GPAs as those who did not

graduate. (2) The results from analysis of covariance showed that among those who graduated with an engineering degree, the final GPAs between the experimental group and the control group were not statistically different after controlling for the initial GPAs. (3) The experimental group completion rate was statistically significant higher than the control group.
We concluded that the loan repayment award not only had a positive influence on completion rates, but also influenced completion by a greater variety of students in terms of GPAs. Students in the experimental group had a wider range of GPAs and lower average GPA than the control group, suggesting that loan repayment may improve persistence for engineering students with lower GPAs. We argue that the findings presented here may have the potential of changing how the resources be distributed to intervention programs. The result-based financial support may be used as a new way to recruit students of underrepresented populations including women and minority students.

Introduction

While women have become well represented in some STEM (Science, Technology, Engineering, and Mathematics) fields such as biology, life science, and medical fields in recent years; they remain severely underrepresented in engineering (National Science Foundation, 2013).[1] Among those who enter engineering, women are more likely to drop out of the major than men. Extensive research has been conducted on retention for women in STEM and students in general. Research has indicated that financial difficulty is among the top factors influencing retention of students in engineering in general, underrepresented students, and non-traditional students.[2-4] Yet little research has looked the influence of financial factors on retention of women. This study examined how financial support influenced the retention and academic achievement of women in engineering.

Unlike many studies that are based on data collected from multiple institutions (cross-sectional) or collected at one-time point, this study examined the retention of a cohort of undergraduate engineering women at a single institution, Kansas State University. The female participants were tracked for multiple years until they graduated with a bachelor's degree in engineering or changed their majors, transferred, or dropped out. Therefore, in this study, retention is defined by graduation rate in engineering.[5]

Previous studies have examined the usefulness of different types of financial support for students in general or students from underrepresented minority groups.[6-9] For example, scholarship programs based on financial needs and/or academic potential have been implemented at various institutions as early intervention and have shown success in retaining students in engineering disciplines.[6, 7] Paid industry internship allows students to apply theory into practice through experiential learning, and thus has also been used as an approach to retain students engineering.[8]

Offering research assistantship/stipend through work in laboratories or research projects is another approach that has been effective in retaining underrepresented minority students and students in general in engineering.[8, 9] Students who participated in the lab or research projects expressed the sense of community, increased understanding of coursework, and became more excited and motivated by their experience in the research/projects.[8, 9]

This study focused on another type of financial support – a loan repayment award – and its influence on undergraduate women's academic achievement and completion in College of Engineering at Kansas State University. Specifically, a private organization, the E. Eugene Carter Foundation, provided an incentive for degree completion, the Carter Opportunity Award, to undergraduate women in the form of a repayment of subsidized student loans upon completion of an engineering degree. No requirements beyond completion of an engineering degree were stipulated. No time limit for degree completion was designated, and recipients were not required to work in a specific field or location after completion of their engineering degrees.

Student loan repayment is an incentive often used to recruit and retain highly qualified professionals into lower-paying careers or services for a certain period of time. It has been widely used by government agencies such as U.S. Army, National Institute of Health, Department of Agriculture, and Department of Education. To our knowledge, it has rarely been used in engineering and little research has been conducted on it. In this study, we examined whether this financial incentive of a student loan repayment awarded upon graduation influenced undergraduate women's retention and academic achievement in engineering.

Method

Potential participants in the study were selected based on the following criteria: (a) must be a female, (b) must be in good standing in an engineering major, and (c) must have subsidized student loans. Forty sophomore women engineering students, who met the criteria, were initially selected for the study in January 2007. The sample was stratified by first generation status and ethnicity, which made up 20 pairs. Then each of the 20 pairs was randomly placed into the experimental group (selected to receive repayment of their subsidized student loans on completion of an engineering degree) and the control group (not selected to receive loan repayment upon completion of an engineering degree).

This quantitative study used a pretest-posttest quantitative design. At the beginning of the study, students in the experimental group were told that their subsidized loans incurred during their time at Kansas State University would be paid off after graduation with an engineering degree. Students in the control group were not told about the program. At the end of each spring semester, the research team checked whether or not each student was in good academic standing and stayed in the program. The study was completed in 2014 when all participants had either graduated or left engineering.

Participant academic achievement was measured in terms of grade point averages (GPAs). Retention was measured by graduation rates. The initial GPA at the beginning of the study (pretest), the final GPA upon their graduation (posttest), graduation status, and demographic information were collected from all participants. Multiple statistical methods were used including independent *t*-test, repeated-measure analysis of variance, and chi-square test.

Results

There were 20 participants in the experimental group and 20 in the control group at the beginning of the study. Among the 20 students in the experimental group, two students were not retained in engineering, with an attrition rate of 10%. At the end of the study, 18 students from the experimental group completed the program and graduated with bachelor's degrees in engineering. By contrast, in the control group, 12 dropped out or changed to a non-engineering degree program, with a high attrition rate of 60%. At the end of the study, eight students from the control group completed the program and graduated in with bachelor's degrees in engineering (Figure 1). All of the statistical procedures were conducted using Statistical Package for Social Science (SPSS) version 22. The equality of variance assumption was tested for all analyses. It was met in all cases except one where adjusted *t*-test statistics were reported. We used an alpha level of .05 for all statistical analyses.

Table 1 *Means, Standard Deviations, and t-Test for Differences in Initial GPAs by Group*

					95% CI[3]	
	Experimental Group[1]	Control Group	*t*[2]	Sig.	LL	UL
Sample size	20	20				
Mean	2.81	2.67	.61	.548	-.33	.61
SD	0.64	0.81				

Note: 1. Carter Opportunity Award recipients upon earning an engineering degree. 2. Test of homogeneity of variance was satisfied: Levene's $F = 1.76$, $p = .193$. CI = confidence interval; LL = lower limit; UL = upper limit.

Initial GPA Comparisons between Groups

We first examined the initial GPAs of both groups collected at the beginning of the study. The descriptive statistics were presented in Table 1. The results of an independent-samples *t*-test revealed that the initial average GPAs in the experimental group and the control group were statistically identical (Table 1).

However, considering the high attrition rate of participants in the control group, we also examined the initial GPAs of only those who completed the program and graduated with a bachelor's degree in engineering in both groups. The results showed a very different picture. The initial average GPA among those who graduated in engineering in the experimental group was significantly lower than those who graduated in engineering in the control group (2.81 vs. 3.45, Table 2). In other words, participants in the control group who successfully graduated in engineering had disproportionally high GPAs to begin with; whereas participants in the experimental group who graduated in engineering had more heterogeneous initial GPAs. As discussed previously, the experimental group and the control group as a whole were comparable in the variability of initial GPAs. This suggested that those in the control group who did not complete their engineering degrees might have had much lower initial GPAs. This was supported by further comparison between those who graduated in engineering and those who did not within control group and experimental group, respectively (Table 3 & 4). Within the control group, the initial average GPA was 3.45 for those who graduated in engineering versus 2.14 for those who did not, showing a statistically significant difference ($p < .001$, Table 3) in initial cumulative GPAs. Within the experimental group, the initial average GPA was 2.80 for those who graduated in engineering versus 2.85 for those who did not graduate, with no statistically significant difference between the two groups ($p = .972$, Table 4).

Table 2 *Means, Standard Deviations, and t-Test for Differences in Initial GPAs among Those Graduated in Engineering by Group*

	Experimental Group[1]	Control Group	t[2]	p	95% CI[3] LL	95% CI[3] UL
Sample size	18	8				
Mean	2.80	3.45	-3.04	.006	-1.09	-.21
SD	.54	.38				

Note: 1. Carter Opportunity Award recipients upon earning an engineering degree. 2. Test of homogeneity of variance: Levene's $F = 1.55$, $p = .225$. 3. CI = confidence interval; LL = lower limit; UL = upper limit.

Table 3 *Means, Standard Deviations, and t-Test for Differences in Initial GPAs by Graduation Status in Control Group*

	Control Group				95% CI[3]	
	Graduated in Engineering	Not Graduated in Engineering	t^2	p	LL	UL
Sample size	8	12				
Mean	3.45	2.14	5.82	< .001	.84	1.78
SD	.38	.55				

Note: 1. Carter Opportunity Award recipients upon earning an engineering degree. 2. Test of homogeneity of variance was satisfied: Levene's F = .58. p = .458. 3. CI = confidence interval; LL = lower limit; UL = upper limit.

Table 4 *Means, Standard Deviations, and t-Test for Differences in Initial GPAs by Graduation Status in Experimental Group*

	Experimental Group				95% CI[3]	
	Graduated in Engineering[1]	Not Graduated in Engineering	t^2	p	LL	UL
Sample size	18	2				
Mean	2.80	2.85	-.043	.972	-13.93	13.83
SD	.54	1.63				

Note: 1. Carter Opportunity Award recipients upon earning an engineering degree. 2. Test of homogeneity of variance was violated and adjusted: Levene's F = 10.87. p = .004. 3. CI = confidence interval; LL = lower limit; UL = upper limit.

Final GPA Comparisons between Groups

The main purpose of the study was to examine if the Carter Opportunity Award, a financial incentive presented upon graduation, had an influence on participants' academic achievement and retention measured by GPAs and graduation rates. The accumulative GPAs at the time of graduation (final GPAs) from participants in both control and experimental groups were compared while controlling for their initial GPAs. The results of analysis of covariance (ANCOVA) test indicated that the final average GPA of the experimental group (*adjusted Mean* = 3.05, *SE* = .094) and the control group (*adjusted Mean* = 3.08, *SE* = .150) were not statistically different when holding initial GPAs constant (Table 5). As expected, the initial GPA as a covariate did have a statistically significant effect on the final average GPA.

Table 5 *Analysis of covariance predicting final GPA by group with covariate initial GPA*

Effect	F^2	p	η_p^2
Group[1]	.038	.847	.002
Initial GPA	18.029	< .001	.439

Note: 1. Group: 0 = control group, 1 = experimental group Carter Opportunity Award recipients upon earning an engineering degree). 2. Degrees of freedom were 1, 23 for all effects.

Graduation Rates Comparison between Groups

Figure 1 showed that the experimental group had a much higher graduation rate than the control group. We used Chi-square test to compare the expected and the observed numbers of participants who graduated between two groups. The results indicated that group membership had a statistically significant association with whether a participant graduated or not, $\chi^2(1) = 10.99$, $p = .001$, $\varphi_c = .524$. Students in the experimental group were statistically more likely to graduate than those in the control group.

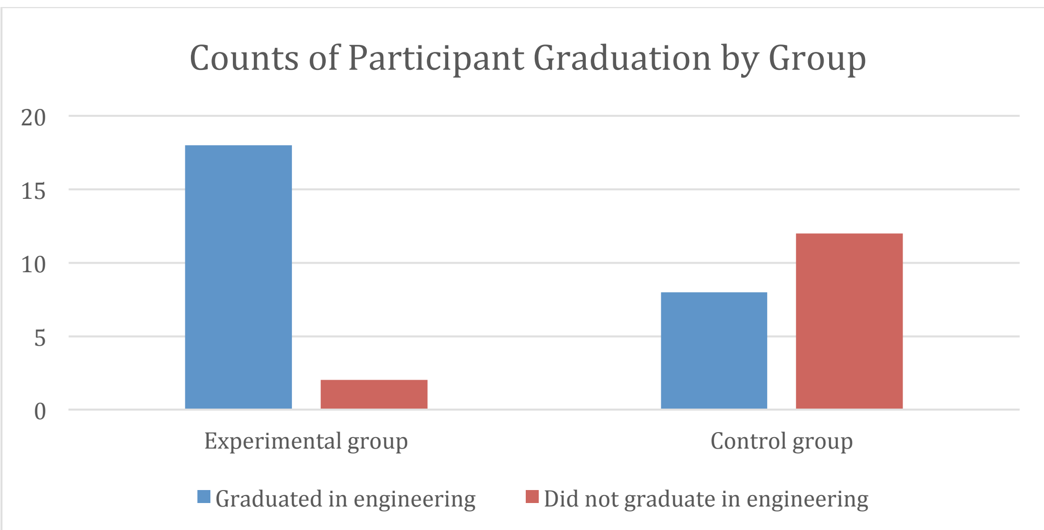

Figure 1. Number of students who graduated by group

Discussion & Conclusions

We concluded that the loan repayment award not only had a positive influence on completion rates, but also influenced completion by a greater variety of students in terms of GPAs. Students in the experimental group had a wider range of GPAs and lower average GPA than the control group, suggesting that loan repayment may improve persistence for engineering students with lower GPAs. A result-based financial incentive like the Carter Opportunity Award could buffer the adversity in engineering and help students who are "not the strongest" survive. We argue that the findings presented here may have the potential of changing how the resources be distributed to intervention programs. The result-based financial support may be used as a new way to recruit students of underrepresented populations including women and minority students.

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