AC 2007-2476: RETAINING FRESHMAN ENGINEERING STUDENTS THROUGH PARTICIPATION IN A FIRST-YEAR LEARNING COMMUNITY: WHAT WORKS AND WHAT DOESN'T

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Retaining freshman engineering students through participation in a first-year learning community: What works and what doesn't

Abstract

A common question among many educators in freshman engineering programs is what can be done in the freshman year to improve the retention of students. Freshman Engineering in the Purdue School of Engineering and Technology at Indiana University Purdue University Indianapolis (IUPUI) is no exception in the search for strategies designed to improve the success of first-year engineering students.

This study took place at IUPUI, an urban research intensive institution. The student population consists mainly of commuter students. The campus's overall 6-year graduation rate is less than 50%. A multitude of efforts on the campus are directed towards improving the graduation rate of all students. One of the most significant of these is the learning community or first year seminar. This institution has long been a national leader in the establishment of learning communities for first-year students.

Learning communities as they exist on this campus are typically 1 credit hour courses taken by first semester freshman students. Briefly, the learning communities are designed to introduce student success skills, to acquaint students with their major area, and to build community and foster relationships among students. There is an abundance of literature in existence that supports the efficacy of learning communities. Most of these are ex post facto studies that have looked at learning communities in general and compared the retention rates and grade point averages of students who participated in a learning community with those who did not. Overwhelmingly these studies demonstrate the advantage of student participation in learning communities. There is, however, very little educational research that discusses engineering learning communities and the effect participation has on student success.

The learning community course designed for engineering students is taken by all first-year engineering majors. There are approximately 150 students enrolled in 6 sections in a typical fall semester. This study builds on our earlier study that looked at the learning community from the viewpoint of engineering seniors and graduates. Some of these results are correlated with results of the current study. The current study utilizes the rigor of educational research methodology and looks at a specific component of the learning community course as well as pre-matriculation perceptions and performance indicators. The study examines the relationships between pre-matriculation variables, first semester GPA, and study skills instruction in the learning community. Various models are analyzed to see if predictors of first semester GPA can be identified.

Introduction

It has long been acknowledged that retention is a major problem at many colleges and universities. Retention issues impact institutions of higher education in a variety of areas ranging from student services through academic affairs and even recruitment of new students. Widely read popular press rankings such as US News and World Reports publish graduation rates.

Lower rates reflect poorly on an institution. Additionally, the failure to retain students impacts both an institution's budget and planning. A student who drops out no longer contributes tuition dollars. According to Mangold, Bean, Adams, Schwab and Lynch[1] "low graduation rates cost universities scarce resources." For these reasons and more, colleges and universities have turned their attention to finding ways to retain the students that do enroll.

A widely-implemented tactic used to improve retention is the learning community or first-year seminar course. (For the purposes of this paper, the terms "learning community" and "first-year seminar" are used interchangeably.) There is much in the literature about learning communities that demonstrate their effectiveness at both reducing student departure and improving GPA. The first-year seminar is a typically a course that contains skills and strategies designed to optimize student success and integration into the life of the institution. Topics such as study skills, time management, and campus resources are commonly covered. These are designed to address and ameliorate the four major issues identified by Tinto[2] that are associated with student departure. These include: adjustment problems, academic difficulty, incongruence or lack of "fit" within the institution, and isolation.

Literature Review

A review of the literature gives testimony to both the variety[3] and success of learning communities at a range of institutional settings[4, 5, 6, 7, 8].

At IUPUI learning communities evolved from a few models developed in the mid-1990s around a general design[9, 10] to over 100 sections that follow a common "template" that attempt to address above topics.[11] IUPUI is considered one of the lead institutions in the development of learning communities. Our learning community course content has been clarified and expanded to also include seven specified learning outcomes. Summarizing the outcomes they comprise the following: 1. development of a perspective on higher education; 2. experience of a safe and supportive environment; 3. practice in communication skills; 4. utilization of critical thinking; 5. utilization of technology; 6. furthering an understanding of self and career goals; and 7. utilization of campus resources. Various schools within our university offer their own version of the learning community. Each, however, includes the template outcomes while at the same time offering students greater insight into particular fields of study offered by each school.

Our freshman engineering program began offering learning community courses (ENGR 195) in 1999. A few years later the learning community became a requirement for the engineering degree. During this same time, there was a rise in interest within the national engineering community about what curricular changes might improve recruitment and retention in the various fields of engineering. An assortment of textbooks beginning with Ray Landis' *Studying Engineering*[12] in 1995 and targeting the first year engineering student began to appear[13, 14, 15, 16]. These texts target the same major areas of attention affecting academic success and adjustment that were identified by Tinto[2] in 1987 and mentioned above. Many engineering colleges and universities in an effort to improve student retention success began implementing some form of learning community in their freshman programs. Ohland and Collins[17] in their meta-analysis of engineering freshman programs catalog a variety of engineering learning communities at 25 institutions. Additionally for much of the past decade, presentations in the Freshman Programs

Division at the American Society for Engineering Education Annual Conferences have featured representatives from an array of engineering colleges describing their own unique first-year-seminar type programs and initiatives[18, 19, 20].

Nevertheless, despite the explosion of attention about first year programs in engineering, there is a significant lack in the engineering learning community literature of a solid body of assessment data about the success of various efforts. One of the speakers at the 2006 ASEE Conference in Chicago stated that many of the conference presentations are more of a "show and tell" nature. He said it is time for the engineering community to more solidly address assess the impact of what is done and how this impacts learning. In fact, as Barefoot[21] points out regarding all first year initiatives "only a small fraction of first-year programs are put to any sort of objective test to determine whether they have achieved intended or unintended outcomes." The learning community and first-year seminar literature mainly reports direct measures such as retention rates and GPA. When compared to control groups, participation in learning communities is seen to correlate to improved retention and higher GPAs. Most studies, however, lack specificity regarding what was done and what impact a particular learning experience had on students.

In this study we looked at selected activities done in the learning community and evaluated the impact these activities had on students. The inquiry attempted to understand the relationships between academic and non-cognitive factors at prematriculation, study skills learned during a learning community course in engineering, and first semester GPA.

Methods

Setting. Indiana University Purdue University Indianapolis (IUPUI) is an urban institution located just west of the central, downtown area of Indianapolis, Indiana. The campus includes schools that grant Indiana University degrees and schools that award degrees from Purdue University. IUPUI serves almost 30,000 students. The campus is home to the Indiana University School of Medicine, the second largest medical school in the United States. While there is a tremendous diversity in student types, the campus enrolls a significant number of first generation, commuter students. Graduation rates at IUPUI are consistently lower than those at peer institutions. This information provided the impetus for implementing learning communities on the IUPUI campus.

As mentioned above, learning communities give attention to those areas described by Tinto[2] that affect student persistence. While our learning community course addresses all areas, in this study we focused our attention mainly on one of them: academic difficulty. In our learning community course we provide instruction about those strategies that are typically necessary for success in college. Our classes meet once a week for 75 minutes. Three weeks into the course we have a presentation on time management and study skills. We deliberately wait until this time. First, enough time has gone by that students will have had some experience with the college work load; but, secondly, it is still early enough in the semester to change or improve habits.

The text used with the course is Landis's *Studying Engineering: A Roadmap to a Rewarding Career*[12]. Students are assigned to read the third chapter, "Academic Success Strategies." Barefoot[21] suggests that college faculty focus on "the strengths of contemporary students." Two of these strengths are their creativity and their technological savvy. Building on this concept, we first assign students a homework project where they are required to create in Excel a schedule for their entire week. This schedule must designate some activity - study time, class time, work time, sleep, etc. – for every one of the 168 hours of the week.

Four weeks later the students are assigned a project that requires that they make a web page. Students were given instruction in how to make a simple web page using FrontPage. The first page of their web page is about study skills. Students are instructed to use their knowledge of study skills and student success to design a page that would inform prospective high school students about what it takes to do well in college. (The second page of their web pages is about engineering. The second page is not part of this study.) Students receive grades that are based on the mechanics of their web page, whether they had required elements, and on how well their pages function overall. Web pages are submitted to instructors via the online course management system.

Participants. Participants in the study consisted mainly of traditional-age, first semester students interested in studying engineering. Qualified students declaring an engineering major are directly admitted to the Freshman Engineering Program. Students not eligible for direct admission are instead first admitted to IUPUI's University College. University College is the academic home for students until they are eligible to enter the school of their choice. Direct admits and University College students interested in engineering all enroll in the engineering learning community, ENGR 195.

Potential participants included all students enrolled in the freshman engineering learning community course (N = 153). Slightly over 50% of the ENGR 195 students were University College students. The number completing the pre-matriculation survey was 102. SAT data were available for 74 participants.

Measures. A *pre-test* modeled after an earlier design used for engineering learning community students was administered at the beginning of the semester. The earlier pre-test was used internally to provide instructors with a snapshot of readiness and computer skill levels. The modifications were included to give us better insights into the preconceptions students bring with them when they enter college. The questions basically can be grouped into three areas: college perceptions, engineering perceptions, and study habits in high school. (See the list of questions in Appendix A.). The college perceptions subscale contains 9 items scored on a 5-point Likert from (1 = strongly disagree to 5 = strongly agree). Samples items include "I understand the difference between high school and college" and "I understand how to use the university library to access materials for my courses." The engineering perceptions subscale contains 6 items scored on a 5-point Likert from (1 = strongly disagree to 5 = strongly agree). Sample items include "I understand what engineers do" and "I can articulate a definition of engineering in today's world." The survey also asks a single item about the number of hours per week students studied in high school. The items ranged from "Less than 1, 1 to 2, 3 to 4, 5 to 6, 7 or more"

The independent variable in the study was a rubric score ranging from 1 to 5 on the *study skills web page*. The rubric score was not given to the student. Students scoring 5 had exceptional web pages that reflected deep understanding and connectedness of the study skills presented in the course. A score of 4 indicated a good sense of student success strategies but were generally less complete than those receiving a higher rating. They generally contained good detail about some components of student success but failed to include other items such as getting to know professors or studying in groups. Those scoring 3 mentioned the importance of time management and of avoiding procrastination but offered less depth beyond stating several skills. Scores of 2 reflected very brief, even one-word listings of elements of student success. For example, a page scoring 2 might just say "Avoid Procrastination" but contain no other comments and/or few links to substantive pages related to study skills beyond the university's main page. Students scoring 1 either did not submit the assignment or were in other ways extremely deficient.

The dependent variable in the study was first semester grade point average as calculated by the university. First semester GPA's ranged from 0 to 4.0. Students' SAT math score was included as a control variable.

Data Analysis

We employed both descriptive and inferential statistics to understand students' perceptions of college and engineers and their relationships to academic achievement respectively. We calculated the mean score and frequency for each item on the survey and created the subscale averages for the college perceptions and engineering perceptions constructs. Next we ran a correlational analysis to examine the relationship between each of the variables. Once first semester GPA's were available, a step-wise least squares regression analysis regressing first semester GPA onto the independent variables (study skills web-page rubric), controlling for college perceptions, engineering perceptions, study hours in high school, and SAT score on the math section was conducted. Math SAT was entered in the first model and the second model included the two perceptions subscale averages and the self-reported study hours in high school. The final model added the independent variable of interest; study skills rubric score.

Table 1 presents the frequencies, means, and standard deviations for the pre-matriculation survey. In the subsequent analyses, the first nine items were categorized as college perceptions and the following six items were categorized as engineering perceptions. The average score on the college perceptions sub-scale was 3.85 with a standard deviation of 0.56. The subscale average for the engineering perception items was 3.78 with a standard deviation of 0.66. The college perception items with the lowest average responses were library use and study skills. The highest responses were found in the students' perceived understanding of the difference between high school and college and ability to adjust to college life. Among engineering perceptions, the lowest scores were for perceptions of understanding what engineers do and the ability to articulate a definition of engineering. Highest scores were associated with functioning effectively in teams and understanding the value of collaborative effort. The teamwork items were grouped with engineering perceptions rather than college perceptions due to the important role of teamwork in engineering.

First semester GPA was used as a measure of student success. The average GPA for the student sample studied was 2.72 on a 4-point scale, with a standard deviation of 0.96. Math SAT score proved to be a significant parameter in correlation studies. Math SAT score was available for only 74 participants since others either did not have scores or took the ACT instead. The average math SAT score was 565 with a standard deviation of 92. This average includes the scores of participants not admissible to engineering directly from high school. Another significant parameter was the self-reported number of hours studied in high school. The average value reported in Table 2 was 2.9, translating to a value of less than three hours per week. The standard deviation of 1.27 indicates a low variation in number of hours studied. Only 14 students of the 96 responding to this item indicated that they studied seven or more hours each week while another 14 studied less than an hour a week.

Table 1. Frequencies, Mean, and Standard Deviation for Survey Items

Item	Frequencies					Mean	Std Dev
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree		
College Perception Items							
I understand the difference between high school and IUPUI.	1	1	4	22	70	4.62	0.71
I know about the services that support students on campus?	2	7	34	35	20	3.65	0.95
I know what behaviors constitute academic misconduct?	2	3	15	26	50	4.24	0.97
I have good study skills.	2	13	33	35	15	3.49	0.98
I have good time management skills.	0	8	38	36	15	3.60	0.85
I understand how to use the university library to access materials for my courses.	8	24	26	27	13	3.13	1.17
I understand how to use the Oncourse system at IUPUI	3	4	11	44	36	4.08	0.96
I will adjust to college life.	1	0	11	43	42	4.29	0.75
I can access information about jobs, internships and co-ops.	4	13	30	30	20	3.51	1.09

Engineering Perception Items							
I can function effectively in a group or team setting.	2	3	9	39	45	4.24	0.90
I understand the role of engineering professional societies.	2	11	30	35	18	3.58	0.99
I understand what engineers do.	3	20	43	32	0	3.06	0.81
I can articulate a definition of engineering in today's world.	3	11	32	37	14	3.49	0.98
I understand the role of engineers in society.	1	4	21	44	27	3.95	0.87
I understand the value of collaborative effort.	0	4	6	37	49	4.36	0.78
Self-reported Study Hours in High School							
	Less than 1	1 to 2	3 to 4	5 to 6	7 or more		
How many hours per week did you study in high school?	14	26	26	16	14	2.90	1.27

Table 2. Student Performance Indicators

Measure	Mean	Standard Deviation
Math SAT Score	565	92
First Semester GPA	2.72/4.00	0.96

Table 3. Pearson Correlations of Questionnaire Items and Direct Measures of Student Success

	Math SAT score	First semester GPA	Perceptions of college	Perceptions of engineering	Self-reported high school study hours	Score on study skills rubric ENGR195
Math SAT score	1					
First semester GPA	.435**	1				
Perceptions of college	-.083	.087	1			
Perceptions of engineering	.172	.194	.571**	1		
Self-reported study hours high school	.251*	.235*	.254*	.251*	1	
Score on study skills rubric ENGR 195	.234	.423**	.144	.038	.214*	1

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

The pearson correlations in Table 3 display the bivariate relationships between pre-matriculation perceptions, study hours, math SAT and post-matriculation measures including first semester GPA and assessment of a study skills web page assignment in ENGR 195. Significant correlations emerged between the self-reported number of hours studied each week in high school and perceptions of college and engineering, first semester GPA, and performance on the study skills assignment. There was a significant correlation between the SAT math score and the first semester GPA and between the score on the study skills web page completed for ENGR 195 and first-semester GPA. Also, perceptions of college correlated significantly with perceptions of engineering. Perceptions of college and engineering were positively, but not significantly related to first semester GPA.

Table 4. Step-wise Regression Analysis Predicting First-Semester GPA

Variables	Model 1	Model 2	Model 3
Math SAT Score	0.005** (0.001)	0.004** (0.001)	0.003* (0.001)
Perceptions of college		0.110 (0.252)	0.059 (0.246)
Perceptions of engineering		0.218 (0.218)	0.233 (0.211)
Self-reported study hours high school		0.100 (0.096)	0.073 (0.094)
Score on study skills rubric ENGR 195			0.180* (0.086)
R	0.47	0.54	0.58
R^2	0.22	0.29	0.34
Change in R^2		0.07	0.05

* $p \leq .05$
** $p \leq .01$
Note: Standard errors are in parentheses

The step-wise regression results are presented in Table 4. Math SAT was a significant predictor of first-semester GPA in the first model, explaining 22% of the variance. Adding perception scores and study hours contributed an additional 7% of the variance in first semester GPA. When the study skills assignment was included in Model 3 of Table 4 along with SAT, perceptions, and study hours, a total of 34% of the GPA variation can be attributed to variables in the model. In this final model, both study skills and SAT score were significant predictors of first-semester GPA.

Discussion

Conclusions. The results of this study give us clear evidence that the instruction given in the ENGR 195 course to first year engineering students about student success strategies does matter. The ability to communicate study skills strategies that were presented in ENGR 195 and as evaluated in the rubric grade was a significant predictor of first semester GPA. In order to do this assignment students had to process the study skills instruction and then present it in a creative format. While SAT math score emerged as a strong predictor of first semester GPA, when the study skills scores were included in a model along with SAT score, engineering and college perceptions, and high school study hours, 34% per cent of the variation in GPA could be explained. Of these factors, only the study skills assignment was an intervention made after matriculation. The other factors were pre-existing.

Self-reported study hours in high school correlated significantly with most of the variables studied but was not a predictor in the linear regression analysis. The pre-matriculation survey results show that 69% of the students studied less than four hours a week. This commitment to study outside of class is far lower than what college faculty expect of students who eventually graduate in engineering. The relatively high pre-matriculation scores on college perceptions suggest that students believe they understand the differences between high school and college. Students are entering our classrooms confident that they know how to succeed. High scores on the pre-matriculation engineering perceptions correlate significantly with the college perception scores, indicating further the high level of confidence of the students upon matriculation. However, we have found that there is no significant relationship between pre-matriculation college and engineering perceptions and actual success as measured by first semester GPA. Simply stated, students are enrolling with self-confidence but also with unrealistic perceptions of college work. This is supported by Felder[22] who says, "A sizable percentage of high school students lack the sound judgment, sense of responsibility, and work ethic to do well in a curriculum as demanding as engineering, and they're not likely to magically acquire these things in the summer between high school and college."

It is important that faculty who work with freshman students are aware of both perceptions and the need to provide interventions that promote success. While Sidle & McReynolds[23] found that the majority of students taking a learning community course agreed that "taking the course…increased their belief that they could succeed," they did not evaluate specific activities and the effectiveness of those activities. Borden et al.[9] call for "systematic and evidence-based processes for [learning community] program development." This study provides first-year faculty with an element of evidence that supports the inclusion of instruction in student success strategies in first year programming.

Limitations. This study has some limitations. The first mainly derived from the fact that study participants were all located at a single institution. The sample population may not be reflective of first year students in engineering programs at other institutions. Furthermore, the sample size of 100 is relatively small. Both of these limitations suggest that generalizing the results to include all institutions and student types may not be valid. In addition, the study skills assignment was graded; therefore it may not accurately reflect a student's actions.

Further limitations include missing data points. Some students did not have SAT results. Either they took the ACT or, in some cases, were non-traditional students and were admitted without test scores. Additionally, since the survey was optional some students chose not to participate.

Future Studies. As freshman engineering faculty we continue to be interested in determining what actions can be taken during the first year that will promote and positively impact retention. In a previous study we looked at learning community participation from the view of seniors or graduates in engineering[24]. In that study we utilized both quantitative and qualitative research methods to query 27 seniors and recent engineering graduates about the helpfulness of the specific learning community topics. The research design included both a survey and several qualitative questions. Additionally, several students participated in interview sessions. One of the major themes that emerged in the senior study was that respondents found that the learning community course was helpful in getting them started on the college process including providing information about student success strategies.

Respondents in the senior study had taken the learning community course several years prior to their participation in the study. In some cases respondents had difficulty recalling experiences from their freshman year. We are interested in surveying students about the helpfulness of learning community topics closer to the time that they participated in the course. We plan to continue to follow the students involved in the current study. Many of these students are enrolled in courses taught by freshman engineering faculty. The students will be given a survey similar to the one given in the senior and graduate study at the end of the freshman year. This survey will include all learning community topics. We also plan to conduct interviews to provide further depth and insights from students about their study skill behaviors. Additionally, we will continue to track the retention of the study participants.

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