

Extended Abstract – The Effects of First-Year Client-Based Projects on Student Retention

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Abstract - The Michigan State University (MSU) College of Engineering has developed a large-scale initiative, the CoRe Experience, that integrates a first-year engineering academic program and an engineering living-learning community to support the academic, personal, and professional growth of early engineering students during this challenging transition from high school to college. Our long-term goal is to provide the foundation for educating these students to be better, more successful professional engineers. However, in the short term, it is critical that we support these students to the greatest extent toward secondary admission to the College of Engineering. Historical data shows that the majority of our students (~85%) who gain admission to the College graduate from the College.

Over the last several years, CoRe has incorporated service learning projects into the first-year design course, EGR 100: Introduction to Engineering Design. These projects have been offered to student teams in addition to several more general, somewhat discipline-specific projects (e.g., robotics challenge or model solar car competition). For many of the service learning projects, MSU units, such as the Resource Center for Persons with Disabilities (RCPD), Residence Education and Housing Services (REHS), the Residential Initiative on the Study of the Environment (RISE), the Residential College in the Arts and Humanities (RCAH) and the Engineers Without Borders (EWB) student chapter, have provided initial project specifications and served as clients for the student teams.

In the 2014-15 academic year, industrial partners also served as clients for EGR 100 projects. These projects included designs specific to sponsor needs (e.g., a monitoring system for an overhead crane or a safety system to reduce employee injuries) as well as non-specific, open-ended problems (e.g., framework for an autonomous vehicle design).

To assess the influence of these service learning and industry-sponsored projects (collectively client-based projects) on student retention, we began collecting data following the 2013-14 academic year regarding the scholastic progress of EGR 100 students that were members of teams working on the general projects vs. those who worked on client-based projects. Our goal in assembling and analyzing these data is to determine if the retention of students is significantly different

between the two groups. Here we present recent findings that extend our prior results.

Index Terms – first-year engineering, service learning, client-based, design projects, STEM

INTRODUCTION

In line with national priorities, Michigan State University seeks to improve retention and success of first-year engineering students through its CoRe Experience program [1]-[2]. One driver for student persistence is engagement in the work they are doing, with service learning projects having been shown by us and others to be of unique interest to particular student populations and to result in enhanced student engagement [3]-[7]. Student *interest* in a topic or discipline can be differentiated into individual interest and situational interest [8]. Research on student engagement and learning has indicated that situational interest, which may emerge when a student is placed in an “interesting” context such as a service learning project, is likely to enhance academic engagement and achievement [9]. The service learning projects in EGR 100 may be a means to heighten and trigger situational interest. The work described herein continues a long-term examination of the effect of service learning and other client-based projects in our first-year course on student retention.

Course Detail: Introduction to Engineering Design

We have described our first-year design course, EGR 100: Introduction to Engineering Design, previously [10]. The principal goals of the course are to provide students the opportunity to utilize the engineering design process through hands-on project work, develop teamwork and communication skills, apply their creativity, and develop an appreciation for professionalism and ethics in engineering practice.

Project Detail

EGR 100 concludes with an eight-week project where student teams select from the available offerings (see below). Generally, the projects can be divided according to whether they have a client (service or industrial) or not. After considerable development [1], by Spring 2015, students could select from ten different projects, namely:

EGR 100 Service Learning Projects (students):

- EWB Water Heater (209)
- EWB Water Filtration (118)
- EWB Composting Latrine (22)
- RCPD Basic Electronics (86)
- RCPD Hand Cycle Transfer Aid (26)
- RCPD Middle School Math Tools (29)
- RISE Residence Hall Waste Reduction (145)
- RCAH/EGR Art Project (6)

EGR 100 Industry Sponsored Projects (students):

- Parking Lot Winter Safety (15)
- Overhead Crane Rail Conflict Detection (23)
- Autonomous Vehicle (32)

EGR 100 General Projects (students):

- Cell Phone App Design with App Inventor (284)
- Solar Car Competition (254)
- Solar Water Heater Design (380)

While we have categorized the projects as above, the students selected from a single unclassified list, based on the project title and a brief description from the teaching assistant leading the laboratory section. Thus, students may not have been aware of the fact that they were going to be involved in a client-based project when selecting the project initially.

Study Detail

The purpose of our study was to determine the characteristics of students who selected client-based projects compared with those who selected general projects and identify any relationship between project choice and retention in the MSU College of Engineering. Student persistence was determined through an analysis of MSU Registrar data. Students in our analyzed population were divided into two categories. *Persisters* were those that at the time of the data query (Spring 2015) were engineering students. *Leavers* were those that had at some time been engineering students, but were, at the time of data query, in non-engineering majors at MSU [1]. We examined data from students who took the course in Fall 2014 (n=925) and Spring 2015 (n=704).

Data from the two semesters examined are shown in Table I. In addition to the listed data, we found a gender distribution of 319 (19.6%) women and 1310 (80.4%) men.

TABLE I

SEMESTER DISTRIBUTION OF STUDENTS INCLUDING THOSE WORKING ON CLIENT AND GENERAL PROJECTS

Semester	Total Students	Client Projects	General Projects	Total Persisters	Total Leavers
Fall 2014	925	187	738	847	78
Spring 2015	704	524	180	665	39

PRELIMINARY RESULTS

We analyzed Registrar data and project type (client-based vs. general project) for the students for whom we had complete data. Information on persistence, gender, ACT and math placement test scores, and major was included in the analysis.

In examining course grades, the students who selected client-based projects earned an average grade of 3.575/4.000 in the course (std dev 0.7832, n=711). Students selecting general projects had average course grades of 3.657/4.000 (std dev = 0.6525, but they were not significantly different ($p = 0.149$, Mann-Whitney U test).

Based on our average student populations, we calculated the frequency of students choosing the client-based projects relative to their representation in the total population. In doing so, we found environmental, civil, and biosystems engineering students preferentially chose client-based projects (Table II, column 4) while computer science and applied engineering sciences majors more frequently chose not to work on client-based projects. All other majors, including non-engineering majors, fell within $\pm 3.00\%$ of the expected distribution.

We were then able to compare data collected from the EGR 100 course to those obtained from the MSU Registrar's office. The Registrar data provided gender as well as persistence in the College.

Women chose client-based projects 13% more frequently than expected by chance, and men chose client-based projects 3% less frequently than expected by chance (chi-square = 5.003, df = 1, $p = .025$).

We compared the persistence of students as engineering majors by whether or not they had worked on a client-based project versus a general project. Because the students represented in this analysis took EGR 100 in the past academic year (2014-2015), the overall persistence for the entire data set is 92.8%. This is not surprising as most leavers exit after the first year.

We also examined the ACT composite and math scores of the EGR 100 students by project type selected. We found the average ACT composite score for client-based projects to be 26.546 and the General projects to be 27.392 ($p < 0.001$). A similar trend was seen with ACT math scores. Overall, students selecting client-based projects had lower incoming ACT Math scores (27.146) than General projects (28.212; $p < 0.001$). Students doing client-based projects also scored lower on the MSU mathematics placement exam for incoming students (18.791) than those selecting general projects (19.835, $p < .005$).

TABLE II
TOTAL NUMBERS OF STUDENTS WORKING ON CLIENT-BASED AND
GENERAL PROJECTS – FALL 2014

Major When in EGR 100	Client- Based Projects	Client- Based %	Diff to Total %	General Projects	General Project %	Total Numbers of Students
Appl Sci	5	16.67%	-3.53%	25	83.33%	30
Bio Eng	9	23.08%	2.88%	30	76.92%	39
Chem Eng	28	22.05%	1.85%	99	77.95%	127
Civil Eng	15	34.88%	14.69%	28	65.12%	43
Comp Eng	11	17.46%	-2.73%	52	82.54%	63
Comp Sci	21	14.79%	-5.41%	121	85.21%	142
Elec Eng	14	20.29%	0.10%	55	79.71%	69
Eng No-Pref	24	19.83%	-0.36%	97	80.17%	121
Env Eng	7	35.00%	14.81%	13	65.00%	20
Matl Sci	2	22.22%	2.03%	7	77.78%	9
Mech Eng	39	20.53%	0.33%	151	79.47%	190
Other	12	16.44%	-3.76%	61	83.56%	73
Totals	187	20.19%		739	79.81%	926

TABLE III
TOTAL NUMBERS OF STUDENTS WORKING ON CLIENT-BASED AND
GENERAL PROJECTS – SPRING 2015

Major When in EGR 100	Client- Based Projects	Client- Based %	Diff to Total %	Non-Client Based Projects	Non-Client Based %	Total Numbers of Students
Appl Sci	16	69.57%	-4.87%	7	30.43%	23
Bio Eng	12	92.31%	17.88%	1	7.69%	13
Chem Eng	49	76.56%	2.13%	15	23.44%	64
Civil Eng	25	71.43%	-3.00%	10	28.57%	35
Comp Eng	32	71.11%	-3.32%	13	28.89%	45
Comp Sci	76	73.08%	-1.35%	28	26.92%	104
Elec Eng	38	74.51%	0.08%	13	25.49%	51
Eng No-Pref	49	72.06%	-2.37%	19	27.94%	68
Env Eng	15	75.00%	0.57%	5	25.00%	20
Matl Sci	7	87.50%	13.07%	1	12.50%	8
Mech Eng	118	77.12%	2.69%	35	22.88%	153
Other	87	72.50%	-1.93%	33	27.50%	120
Totals	524	74.43%		180	25.57%	704

We also administered the Purdue Spatial Visualization Tests: Rotations (PSVT:R) to all students. Students who completed client-based projects had lower scores (21.84) on the 30-point exam than those doing general projects (22.77, $p < .005$).

Since women selected client-based projects more frequently than men, but all students who selected client-based projects had lower scores in math and spatial reasoning, both of which are predictors of success in engineering, we examined differences by gender. Women had lower spatial scores (20.34) than men (22.89, $p < .001$) as we have seen in our previous studies [2]. Women had lower ACT Math (27.112 vs. 27.934, $p < .002$), but not lower math placement scores. However, women had higher grades in the course (3.810 vs 3.572, $p < .001$) and higher GPAs at the end of Spring Semester (3.279 vs 3.052, $p < .001$).

GENERAL CONCLUSIONS AND CONTINUING STUDIES

Echoing our prior results [3], we continue to find that students who select particular majors are more or less likely to participate in client-based projects. Although, some of the

differences are more subtle since we increased the numbers of client-based projects. Moreover, the gender differences we have seen continue to be present. We are continuing to investigate how participation in these projects drives student interest, motivation, and persistence longitudinally through their undergraduate careers. We are also structuring our future activities to separate the self-selection bias that may in part cause the differences in the persistence and success of students who have participated in these project activities. One interesting area of study we are currently investigating is to qualitatively code the proposals that students write to select one of the projects from the list. This may help us identify whether students are selecting these projects due to individual or situational interest.

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