AC 2012-4948: INTRODUCTION TO ENGINEERING: PREPARING FIRST-YEAR STUDENTS FOR AN INFORMED MAJOR CHOICE

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Introduction to Engineering: Preparing First-Year Students for an Informed Major Choice

Introduction

A new Introduction to Engineering course designed to introduce the engineering profession and to prepare students to make an informed discipline-major choice, was piloted in preparation to replace the current introduction-to-major courses currently taught in the College of Engineering and Applied Science at the University of Colorado Boulder. The course objectives for this one-credit pilot are to:

1. Discover the engineering profession
2. Learn about the College's disciplines and majors
3. Learn about the transition to university and college life
4. Organize for academic success

The National Academy of Engineering (NAE) Engineering Grand Challenges[1] were chosen to provide relevance and context for a multidisciplinary introduction to the engineering profession, and a point of view from which to compare and contrast the disciplines, and the degree majors of the College.

The current one-credit introduction-to-major courses do not meet the first two course objectives because they "stovepipe" first-year students directly into a discipline major and provide no formal contact with students of the other engineering discipline majors. A review of the content of the introduction-to-major courses revealed that the degree to which the third and fourth course objectives are met is discipline major and instructor dependent. The new course will guarantee a broad, multidisciplinary introduction to engineering. This not only has value to help students make an informed major choice; pedagogically it is a first opportunity to emphasize the multidisciplinary nature of contemporary engineering practice. Therefore, the pilot course was delivered with the expectation that it will replace the current introduction-to-major courses.

The course objectives address both first-year pedagogy and the overall first-year experience. Accordingly, this paper is presented in two major parts. The first part describes the design and pilot of the new GEEN 1500 Introduction to Engineering course in Fall 2011. The second part is focused on a broader look at the first-year experience with research from Teaching as Research (TAR) projects supported by the Center for the Integration of Research, Teaching, and Learning (CIRTL).

Part 1: Pilot of the New Introduction to Engineering Course

Motivation for Change

First-year students entering the College matriculate into the discipline majors listed in Table 1, or choose the OPEN option that provides flexibility for students to explore the engineering majors for up to two semesters prior to their discipline-major choice. The College has previously offered an introduction to engineering course for students who choose OPEN; the pilot replaced this course, so that the enrollees are primarily OPEN students.

Table 1 Majors in the College of Engineering and Applied Science.

Major	Acronym
Aerospace Engineering Sciences	ASEN
Applied Mathematics	AMEN
Architectural Engineering	AREN
Chemical Engineering	CHEN
Chemical and Biological Engineering	CBEN
Civil Engineering	CVEN
Computer Science	CSEN
Electrical Engineering	EEEN
Electrical and Computer Engineering	ECEN
Engineering Physics	EPEN
Environmental Engineering	EVEN
Mechanical Engineering	MCEN

Figure 1 shows that on average, students who entered the College with a declared discipline major, changed their major within the College about twice as often as those who entered as OPEN. OPEN students however, changed to majors in other colleges about 40% more often than those who entered with a declared engineering major. First-year students who matriculated into an engineering major left the University at a slightly higher rate than those entering as OPEN. OPEN students, who stayed in the College to declare a discipline major, were retained in the College at a slightly higher rate than those who entered with a declared discipline major.

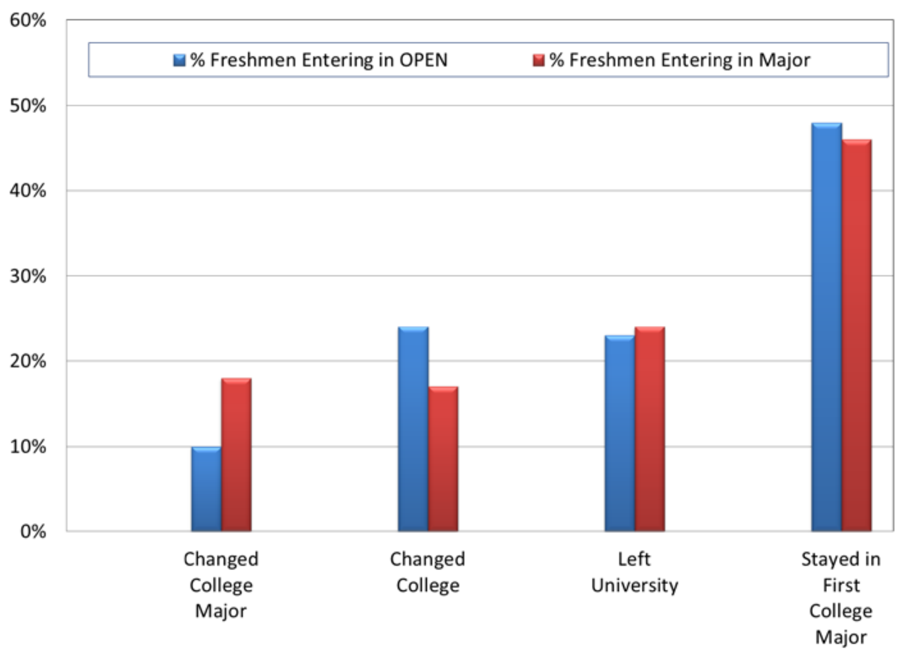

Figure 1 Average persistence in major of cohorts entering Fall 2004 – Fall 2006.

In addition to the pedagogical arguments for a broad multidisciplinary introduction to the engineering profession, to be discussed later, the persistence data showed that students who chose the OPEN option, and who stayed in the College, were less likely to later change their engineering major, and if they did change their engineering major, to only do so once.

The discussion to address the first-year experience, which led directly to the creation of the current pilot course, was initiated because demand for a few popular majors required the application of a policy to limit enrollments for a few oversubscribed majors. The College took this opportunity to review the entire first-year experience, and a task force consisting of all the department chairs, and program directors within the College, and the chairs from the Arts & Sciences College, that deliver the required math and science courses, was convened to review the resource and pedagogical issues, the relevant literature, and best practices at other universities. The task force activities were supplemented by a series of three college-wide workshops/retreats, facilitated by a well-known expert in first-year engineering education.

Figure 2 shows the demand for engineering majors by students matriculating into the first year as OPEN during the years 1997-2010. A policy that enforced enrollment limits was applied to MCEN starting with the entering cohort of 2005, and ASEN in 2006. An unanticipated consequence of the policy was to make it more difficult for OPEN students to declare MCEN or ASEN as majors at the completion of their second semester. This resulted in an increase in the number of OPEN students who declared other discipline majors. CVEN saw the greatest enrollment increase resulting from the policy, that major is also plotted separately in Figure 2.

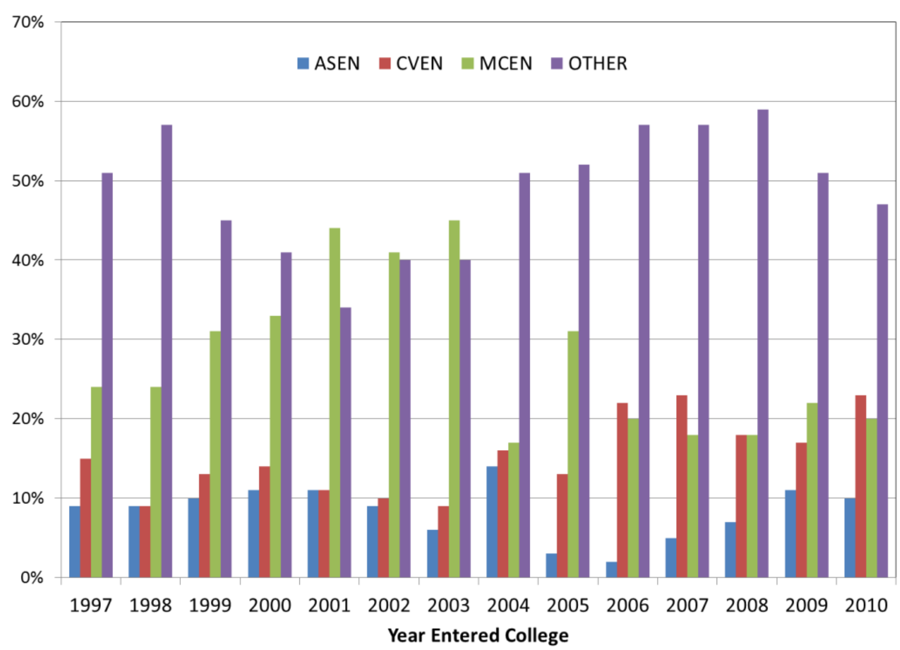

Figure 2 Demand for engineering majors by students entering the College with the OPEN option, 1997-2010. ASEN, CVEN, and MCEN are indicated separately because of their relatively large enrollments and enrollment limits for ASEN and MCEN. OTHER includes the remaining nine majors listed in Table 1.

Course Structure

The pilot course was designed to provide a uniform look into the engineering disciplines. As stated earlier, the course was derived from a course that was currently taught as the general introduction to engineering course, primarily for OPEN students. The pilot is designed to prepare the College for a single introduction to engineering course that will replace all current introduction-to-major courses, and will be required for all incoming first-year students. An early concern presented to the pilot course design team was that the course would create an “arms race” between the majors, where a student’s choice might be unduly influenced by how the major was presented relative to the other majors. The course design team viewed this concern as a potentially positive pressure to ensure that the programs use their “best” teachers to engage students early.

The pilot course was designed to emphasize the three-dimensional view of engineering learning that addresses the dimensions of disciplinary knowledge, identification, and navigation.[2] A typical student attends a 50-min plenary session and a 50-min discipline module session each week, over the 15-week semester. Table 2 shows the schedule details where the numbers in parentheses are the maximum enrollments based on a total enrollment of up to 180 students. The initial enrollment was 134 students, with 105 of these being engineering OPEN students. There were 112 freshmen, 19 sophomores, and three juniors; 126 students completed the course.

Table 2 Fall 2011 master schedule; max enrollment indicated in parentheses.

<table>
<tr><th>Time</th><th>Mon</th><th colspan="2">Tue</th><th>Wed</th><th>Thu</th><th>Fri</th></tr>
<tr><td>4:00</td><td></td><td colspan="2" rowspan="2">Plenary (90)</td><td rowspan="2">Module (60)</td><td rowspan="2">Plenary (90)</td><td></td></tr>
<tr><td>4:30</td><td></td><td></td></tr>
<tr><td>5:00</td><td></td><td rowspan="2">Module (30)</td><td rowspan="2">Module (30)</td><td></td><td rowspan="2">Module (60)</td><td></td></tr>
<tr><td>5:30</td><td></td><td></td><td></td></tr>
<tr><td>6:00</td><td></td><td colspan="2"></td><td></td><td></td><td></td></tr>
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Plenary Sessions

The plenary sessions were delivered by a team of two instructors who focused on topics of the engineering profession that are common across the disciplines and majors. Given that the plan is for the new course to supplant the current introduction-to-major courses, consideration was given to ensure that ABET-required topics are covered for all the majors. In the first plenary session, a discussion of the Engineering Grand Challenges was used to contextualize the engineering profession and disciplines, and to motivate students to envision themselves as the generation that will/must engineer the solutions to the Grand Challenges. The instructors then explained how the Grand Challenges would be used in the discipline modules to establish a common theme from which to compare and contrast the majors. The second session was designed to specifically address Course Objectives 3 and 4, and the dimensions of identification and navigation.[2] These just-in-time discussions were designed to both welcome the students to the College, and to be clear that the faculty and staff are interested to nurture their development as young adults and rising engineers.

Table 3 outlines the weekly plenary topics. Departments and programs delivered discipline and major overviews. These overviews included a broad description of the discipline, with career information, and curriculum details. The majors discussions started in Week 3 with applied mathematics (AMEN) and architectural engineering (AREN), followed by aerospace and civil engineering, (ASEN) and (CVEN), in Week 4. The major discussions picked up again in Week 7 with chemical engineering, and chemical and biological engineering (CHEN/CBEN), and computer science (CSEN), followed in Week 8 by electrical engineering, electrical and computer engineering (EEEN/ECEN), and environmental engineering (EVEN), and finally with engineering physics (EPEN) and mechanical engineering (MCEN) in Week 9.

Table 3 Plenary topics by week.

Week	Topic
1	*Course Introduction:* Syllabus, Expectations, the Engineering Grand Challenges
2	*The Transition:* College Life, Time management, Campus opportunities; Success is about effort not aptitude; Brain Rules
3	Majors Discussion #1: AMEN and AREN
4	Majors Discussion #2: ASEN and CVEN
5	**Discipline Module I Expo**
6	*Academic Expectations*
7	Majors Discussion #3: CHEN/CBEN and CSEN
8	Majors Discussion #4: ECEE/EEEN and EVEN
9	Majors Discussion #5: EPEN and MCEN
10	**Discipline Module II Expo**
11	*The Profession:* Industry Panel
12	*Engineering Ethics:* Case Studies; Honor Code
13	*Professionalism*: Expectations, licenses, communications, after the B.S.; preparing for finals
14	*Major Selection:* Senior Student Panel, Asst. Dean for Students-reminders; revisit main topics; FCQs
15	**Discipline Module III Expo**

Following the majors discussions in Weeks 3-4, the students were given a “majors essay” assignment. For this one-page essay, the students were required to select two of the four majors that had been presented in the plenary sessions then compare and contrast the two majors, report on an out-of-class discussion about the majors with another student, and then reflect upon their assessment of the major relative to their current interests. After the completion of the second set of major discussions in Weeks 7-9, the essay assignment was repeated for those remaining majors. The plenary assignments concluded with a third and final essay in which the students were asked: “Which major or majors most made you consider engineering as a profession, and why?”; “Which major or majors appealed least to you, and why?”; “Recall Majors Essay

Assignments #1 and #2, will the chats that you had with classmates impact your decision for your major choice? How?"; "Have you made a major choice? Why or why not?"

By Week 6 most first-year students have received grades for the first set of calculus, physics, and chemistry exams. For some students, their first exam scores in these basic science and math courses are their first taste of the reality of college-level academic expectations, and it is well known that this is when many students choose to leave the College, who might otherwise be successful given the time to develop strategies for academic success and self-efficacy.[5,6] Recognizing this critical juncture in the students' first year, the plenary instructors devoted the Week-6 session to encourage students to put their first exam experience into perspective, and to discuss strategies to help them better prepare for future exams; again to address Course Objectives 3 and 4.

Discussions in Weeks 11-13 were focused on the practice of the engineering profession. In Week 11, a panel of eight engineers from several local companies was assembled to discuss their experiences, both as undergraduates, and on the job. Their ages and experience ranged from recent graduates to a former professor/associate dean of engineering, who has returned to industry. The contrast of his experiences with those of the more recent graduates was particularly enlightening. The Week-12 discussion of engineering ethics, ranged from an introduction of definitions and concepts of engineering ethics (e.g., ethics is not the law), to the expectations of personal conduct and the consequences of ethical failure, to how the various professional societies have codified ethical standards. This led to the Week-13 discussion on professionalism that ranged from dress codes, to the importance or requirement of a professional engineering license. In Week 14 a panel of 10 students, ranging from second-year students to recent graduates was assembled to discuss their experiences, in particular what their major choice was and what factors they considered in making their major choice. The panelists also discussed topics such as summer internships, and strategies to prepare for exams (and sometimes to cope with the outcome), homework, and projects.

Discipline Modules

The objectives of the discipline modules were to

- Provide a vertical dive into an engineering discipline, in the context of the Engineering Grand Challenges.
- Provide an overview of the major department or program, including lab tours, meeting faculty members, etc.
- Present the discipline from the perspective of invited practitioners.

As shown in Table 4, the modules were rotated each five weeks so that during the course of the 15-week semester a student participated in three discipline modules. Prior to enrollment, students were given registration instructions to review the three combinations of majors for the modules, and then to select the section (room) based on their particular interest. By design, there was no guarantee that a student could register in the module that they might think they were most interested in. The overarching goal was to give all students some depth in three disciplines, to gain some appreciation of the commonality and differences of the engineering disciplines. Given that students are introduced to all the departments and majors in the plenary sessions, there was little concern that a student would not be properly introduced to the major that they will eventually choose. Note that nominal module enrollments were set at 60, but because of relatively small enrollments for the AMEN and EPEN majors, that timeslot was subdivided into smaller sections with a maximum of 30 students per section. These two sections were then recombined into a single section for the ASEN and CHEN modules that followed, as shown in Table 4.

Table 4 Discipline-module schedule.

Week	Module Section			
	Tue 5:00-5:50 Room 1	**Tue 5:00-5:50 Room 2**	**Wed 4:00-4:50 Room 1**	**Thu 5:00-5:50 Room 1**
1-5	AMEN	EPEN	CVEN	ECEN/EEEN
6-10	ASEN		EVEN	CSEN
11-15	CBEN/CHEN		AREN	MCEN

Guidelines for the weekly discipline module activities are presented in Table 5. The module instructors had great liberty in designing weekly activities; the only requirement was that the students be divided into teams to produce a single module deliverable. The deliverable was a team presentation to demonstrate that the team had explored the application of the module discipline to at least one of the Engineering Grand Challenges. As discussed earlier, the NAE Engineering Grand Challenges[1] were used to focus all the discipline modules onto a common set of "big" problems that will likely shape the careers of many of the current first-year students. The module curriculum focuses on the process to generate engineering design requirements. In this way, the pilot course complements the College's first-year engineering projects course that emphasizes a hands-on design-build-test cycle, so the students start with design requirements and end with a product. For the pilot course, students were required to scope an Engineering Grand Challenge(s), to reduce it to a manageable project, then to develop design requirements.

Several of the module instructors created teams using the Comprehensive Assessment for Team-Member Effectiveness (CATME) TeamMaker tool.[7] As stated, teams were guided in a four-week exercise to scope a project that applies the engineering discipline to a specific Grand Challenge, including some basic calculations for feasibility, cost estimates, and preliminary design requirements. The team deliverable was a poster or a brief slide presentation (or a brief video in the case of one discipline module), that described the Grand Challenge, the scoping activity, and presented the analysis and design requirements. Specifically, the presentation template included the following:

- Problem definition: a) what is the Grand Challenge?, b) a picture or illustration of the issue(s), c) what is the role of the discipline in addressing the Grand Challenge?
- Analysis: a) what is the problem scope, i.e., how large is the problem that the team has chosen? b) results of some basic calculations to provide estimates of cost, effort, range of required materials, political consensus, etc.

- Requirements: a) show solution ideas with illustrations, photos, or diagrams, b) what are the requirements to implement a feasible solution? c) what are the pros and cons, e.g., technical, economic, or environmental issues?
- Discuss alternative approaches

Table 5 Discipline-module activities by week.

Week	Module	Module Activity
1	**Discipline Module 1**	Grand Challenge introduction, team selection
2		Scope project, other activities
3		Research/analysis
4		Presentation prep
5	*Module expo during plenary*	Discipline Speaker/Discussion
6	**Discipline Module 2**	Grand Challenge introduction, team selection
7		Scope project, other activities
8		Research/analysis
9		Presentation prep
10	*Module expo during plenary*	Discipline Speaker/Discussion
11	**Discipline Module 3**	Grand Challenge introduction, team selection
12		Scope project, other activities
13		Research/analysis
14		Presentation prep
15	*Module expo during plenary*	Discipline Speaker/Discussion

Simple scoring rubrics were used by the instructors and students during the presentation "expos" that were held during the plenary sessions in the final (fifth) week of the module rotation. The expos were conducted much like a poster session at a conference, where students and instructors questioned the presenters, then scored according to rubric dimensions and scale. The presentation activity was designed to encourage students to interact and discuss their ideas for how the engineering disciplines might be applied to the Grand Challenges. At a later time, the module instructors also graded the team presentations employing a more detailed scoring rubric to produce a composite score with input from the module instructor, the collective plenary and other module instructors, and students. Other activities in the discipline modules included invited speakers, student/industry panels, and lab tours to introduce the students to the discipline major. A peer assessment was required for each team, and several of the module instructors used CATME TeamMaker as the assessment tool at the end of the module rotation.

Outcomes and Assessment

In addition to the College's general freshman survey, students taking the first-year engineering projects course are separately given a pre- and post- surveys. Students taking the pilot introduction to engineering course were given the same pre- and post-survey to measure changes in their knowledge and perceptions.

Course Objective 1 is to "discover the engineering profession," in part to enable the outcome of an informed major choice. Table 6 compares students' assessment of their knowledge about the engineering profession, with 119 respondents identified in both the pre- and post- survey. The percent compilations represent a combination of the top positive choices for each question (e.g. certain, mostly certain, completely certain). The data indicate a substantial increase in the students' self-assessed knowledge of the engineering profession. The uncertainty implied by the percentage decreases in the other three questions is not surprising, based upon the essays and informal discussions with students. Many students indicated that their increased knowledge about the engineering profession, coupled with the breadth of available opportunities and options, and the potential for engineers to make a difference in society, actually increased their uncertainty about a major choice, or even their certainty of engineering as a career choice. Again, given that these are primarily first-semester OPEN students, this uncertainty is not surprising at the end of the first semester in the College, and their first exposure to the profession and disciplines. These students have not chosen a discipline major, and for most this was their first introduction to the College and to the engineering profession. The data in Figure 1 show, however, that for students entering in the fall 2004-2006 semesters, once OPEN students select their discipline major, they are less likely to change majors compared to those students who matriculate directly into a discipline major.

Table 6 Student perceptions of professional knowledge, and major and career options.

Response Categories (n = 119)	Assessment	
	Pre-	Post-
Knowledge about the engineering profession	62.0%	89.7%
Intention to complete an engineering major	93.6%	88.9%
Certainty re: your major choice within engineering	76.0%	68.5%
Certainty re: engineering as a career choice	83.1%	75.2%

It was expected that a broad introduction to all the engineering disciplines and majors in the College would result in a more uniform selection of the majors. Results from the post-survey do not support this expectation. Forty one percent of the students indicated mechanical engineering will likely be their first major choice. The next highest response was for chemical engineering, at 9%, and the likely choice of any other discipline major was individually 5% or less.

Over the past decade, mechanical engineering has been the most oversubscribed major in the College, and one of the pragmatic goals of the pilot course was to produce an outcome of a wider distribution of the OPEN students across the discipline majors. Even before the exit survey results were available, anecdotal evidence of the outcome was obvious to the instructors immediately after reading the final essays that included the questions: "Which major or majors most made you consider engineering as a profession, and why?", "Which major or majors appealed least to you, and why?", and "Have you made a major choice? Why or why not?" The OPEN students are not required to declare a discipline major until midway through the second semester of the first year. Based on the post- survey results, it appears that not only will the desired outcome of a wider distribution of major choice not be realized, the mechanical engineering major might be even more popular as a choice for OPEN students than was previously the case. Although the essays have yet to be coded to extract qualitative data, the instructors report that the majority of students indicating mechanical engineering as their likely choice cited the "broadness of the major, and the broad range of opportunities." The consensus among the instructors is that this is mostly a preconception of the entering first-year students, or it was a result of how information was delivered in the class. The desire to choose mechanical engineering was often stated in the context of a desire "to keep my professional options as open as possible." A clear message appears to be that all the other majors should take particular care to emphasize the broadness of their discipline's applications. When asked in the first two essay assignments to provide a summary of two majors, then to compare and contrast these two majors, students often described the majors in the narrowest of terms, revealing underlying parochial themes that might not be obvious in the plenary major presentations, and in the modules.

Part 2: Questions for a Broader Look at the First-Year Experience

To support the new first-year course and the College's broader effort to assess the experiences of first-year students, four studies were conducted by graduate Teaching as Research (TAR) Fellows funded through the Center for the Integration of Research, Teaching, and Learning (CIRTL). These studies are aligned with course objectives and focused on first-year experiences. The titles of these studies are: 1) Educating first-year students on the social impacts of the engineering profession, 2) Changes in first-year female students' perceptions of a future in engineering, 3) Determining first-year students' understanding of honor code violations, and 4) Motivational factors for engineering students and the impact on retention. These studies primarily use data from surveys and interviews of students in the first-year curriculum, with some data sets extending back at least two years. Unfortunately, problems with some surveys resulted in a statistically insignificant sample size of only 13 students for study (1), and an unanticipated delay in obtaining University Internal Review Board (IRB) certification resulted in a statistically insignificant sample size of six for study (3). Results are still reported for those cases, as they verify the need to ask the questions, and might suggest trends and motivation for more careful future studies.

Educating First-Year Students on the Social Impacts of the Engineering Profession

This TAR study focused on the teaching of first-year engineering students about the positive social impacts that the engineering profession can have. Pre-post analysis was conducted with only 13 students completing the post- survey and 9 of those also with pre- survey data. Students were asked nine, 7-point Likert-style questions related to the relationships between the engineering profession and society, and asked to rate their agreement with a set of statements. The average responses to four of these statements are shown in Figure 3. Statistical significance was determined using a two-tailed, paired t-test. From these data, it appears that student perceptions of the positive contributions that engineers can have on society decreased significantly over the course of their first semester. Given our knowledge of the importance of messaging related to the engineering profession,[8] this outcome is concerning and this question will be investigated more closely in the future.

On the post-survey, students were asked specifically about the contribution of the pilot course to their understanding of the impact of engineering design on society, ethics, and engineer-client interactions. The average ratings given in Figure 4 show that the pilot course had a slightly higher contribution to ethical understanding than on the impact of engineering design and engineer-client interactions. When asked to describe any events in the pilot course that influenced their views of community service or social responsibility, some students mentioned ethics or an increased feeling of responsibility to improve their communities, supporting the contribution to ethical understanding.

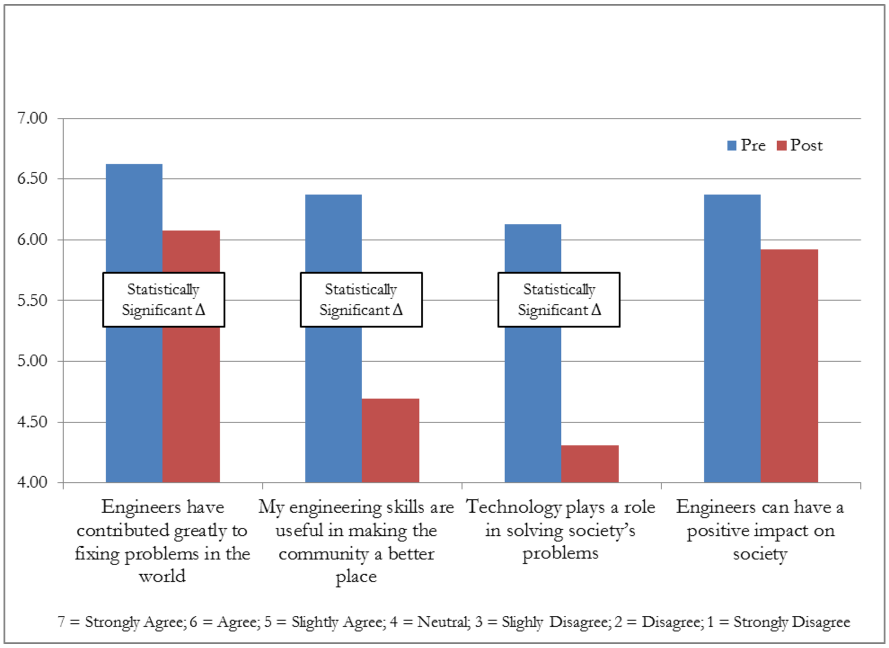


Figure 3 Average level of agreement with statements (n= 13 post, 9 pre & post).

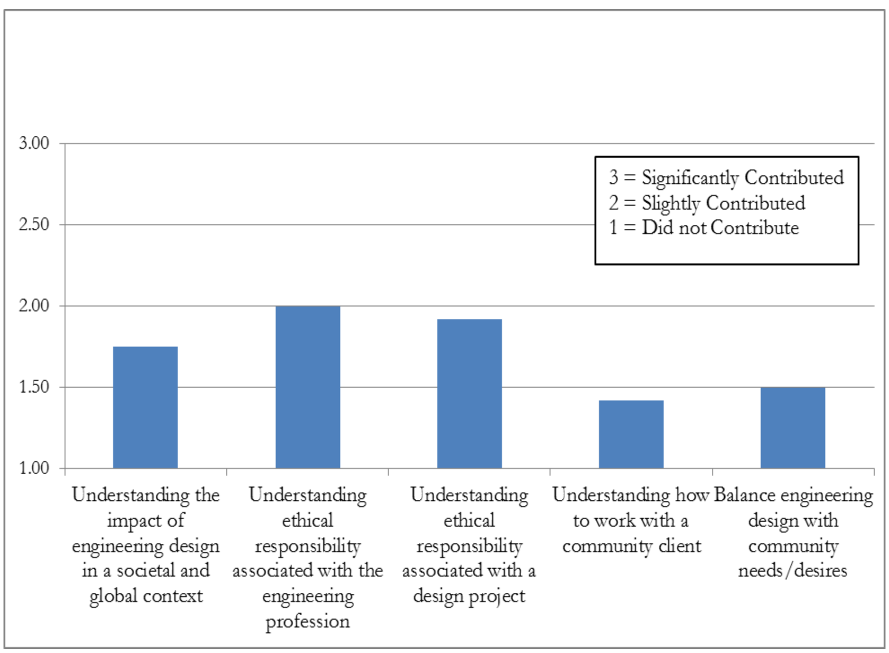


Figure 4 Rate how much the pilot course contributed to skills (n=13).

Determining First-Year Students' Understanding of Honor Code Violations and Contributing Factors

The goal of the study was to determine which actions first-year engineering students believe to be violations of the University's Student Honor Code. The data were collected through one-on-one interviews with students enrolled in the pilot course. Hypothetical scenarios were described to each student, and they were then asked questions about the Honor Code, and then asked to discuss their reasoning for the responses. The plan was to interview 15-20 students, but as stated earlier, IRB certification delays compressed the time available to schedule student interviews, with the result that only six interviews were completed before the end of the semester; interviews will continue to build a statistically significant sample set. The findings discussed here are those that are apparent with the limited data.

The interview content divided the Honor Code into the categories of: a) plagiarism, b) improper group work, and c) the obligation to report cheating. The intent was to determine what type of behavior within each category the participants believe to be Honor Code violations. For the case of plagiarism, the following prompt was given:

> *Michael is enrolled in a Physics elective course in the College of Arts and Sciences, as well as a Structural Engineering course in the College of Engineering. As part of the curriculum for both courses, Michael is required to write a scientific paper. Michael decides to write one paper and turn it in for both courses. As it turns out, the Physics professor is a good friend of the Structural Engineering professor, and it becomes known that Michael turned in identical papers to both courses. Michael is brought up before the Honor Code Committee on charges of plagiarism.*

The intent of this scenario was determine if students understand that it is plagiarism to copy one's own work without proper citation. Four of the six participants said that Michael should not have been brought up on plagiarism charges. When asked what plagiarism is, the same four students all defined it in terms of taking someone else's work and using it as one's own. This implies that students may not be familiar with the concept of self-plagiarism.

The topic of the obligation to report was assessed with a simple scenario in which one student witnesses friends cheating on a take-home exam and does nothing about it. In this case, two participants said it is an Honor Code violation, three said the behavior was unethical but not a violation of the Honor Code, and one said that it was neither. Actually, the University Honor Code is silent about any obligation to report cheating; several other universities, however do require students to report violations of the Honor Code. Therefore, four of the participants were correct to say that there was no Honor Code violation, and it is certainly understandable as to why the other two would believe it to be a violation.

A much larger portion of the interview was dedicated to understanding what students considered to be proper/improper group work. Engineering students are often told that it is okay to work in a group, but each student must turn in their own work. Every participant said that they had been given similar instructions in the past. This is a vague and confusing instruction, so the following scenario was created to explore what students believe is the meaning of these directions:

Christine, Anthony, and Scott are enrolled in an upper-level mechanical engineering course. The professor gives them an assignment with the instructions that it is okay to work in groups, but each student must turn in their own work. Christine, Anthony and Scott work on the assignment together.

The participants were then described six sub-scenarios of how Christine, Anthony, and Scott complete the assignment. These included blatant cheating, clearly acceptable behavior, and some scenarios meant to be less obvious. One of the interesting outcomes was in response to the situation in which "They work through the problems together and end up with the same results, but each turns in their own written assignment." Based on experience in the College, it was predicted that most students would see this situation as ethical and not an Honor Code violation because it is common practice. Two students however, said it is a violation of the Honor Code and one said it is unethical but not an Honor Code violation. This may imply that the interpretation of the instructions changes as students continue into later years or the students' actions do not align with their own definition of Honor Code violations.

Given this same scenario, but where the three hypothetical students indicate their collaborators on the turned-in assignment, all participants agreed that there was no Honor Code violation or unethical behavior. Therefore, if an instructor is looking to clarify the instructions of working in a group, having students indicate all collaborators may be a simple way to coincide with what students believe to be appropriate.

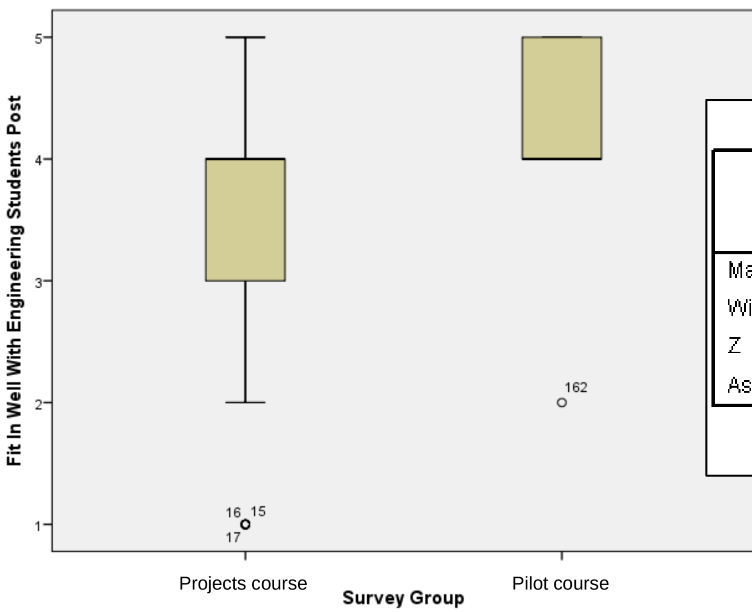
One of the more important results of the interviews is that most students may actually be unaware of the content of the Honor Code. When asked if they knew what is contained in the Student Honor Code, three students referred to the Honor Code pledge, two gave generic descriptions of an honor code, and one said he/she did not know the contents. The half that referred to the pledge gave no indication they were aware that the pledge is only meant to be a daily reminder to obey the Honor Code and is not itself the Honor Code. Even with two students properly describing an honor code, this indicates that over half of the students sampled either do not know what the Student Honor Code says or believe that the pledge is itself the Honor Code. Based on the limited data available, this study indicates that students may not have a solid grasp on the definition of plagiarism as defined by the Student Honor Code and they may be completely unaware of the Honor Code's actual contents.

Changes in First Year Female Students' Perceptions on a Future in Engineering

This study accomplishes two objectives. First, it analyzes pre- (beginning of first semester) and post- (end of first semester) survey responses and retention data from freshman female engineering students, who took the first-year Engineering Projects course, over four semesters. First-year engineering projects courses have been shown to enhance the retention of students, with particularly effectiveness in the retention of women and minority students,[3] so provides a validated basis for comparison. The survey responses are categorized according to retention status in order to develop an understanding of which women leave engineering and why. Second, this study integrates the pre- and post-survey responses from female engineering students in the new pilot course to determine the effectiveness of the course in retaining female engineering students in the College. The combined sample size is 170 students.

The Mann-Whitney Test is used in SPSS[9] for this analysis and boxplots are output. First, the difference in the results between the first-year projects course and the pilot for the post-survey statement, “I fit in well with engineering students” is analyzed since this statement showed correlation with student retention in the projects course. The box plot in Figure 5 indicates that the middle 50% of female students in the projects course answered less confidently (answered 3 to 4 on a scale from 1 to 5) than the middle 50% of female students in the pilot (answered 4 to 5). The structure of the pilot, therefore, may allow female students to realize that they can make friends and fit in with other engineers more so than in the first-year engineering projects course.

The Mann-Whitney Test is next used to indicate the difference in the results between the freshman projects course and the pilot for the post-survey statement: “I am certain that I will have a career in engineering,” because this result also showed correlation with student retention in the projects-course analysis. The box plot in Figure 6 shows that the middle 50% of female students in the projects course answered less confidently (answered 3 to 4 on a scale from 1 to 6) than the middle 50% of female students in the pilot course (answered 4 to 5). By teaching students that engineering careers provide opportunities for engineers to benefit society,[10] the pilot appears to have increased the number of female students who report that they would like a future career in engineering.

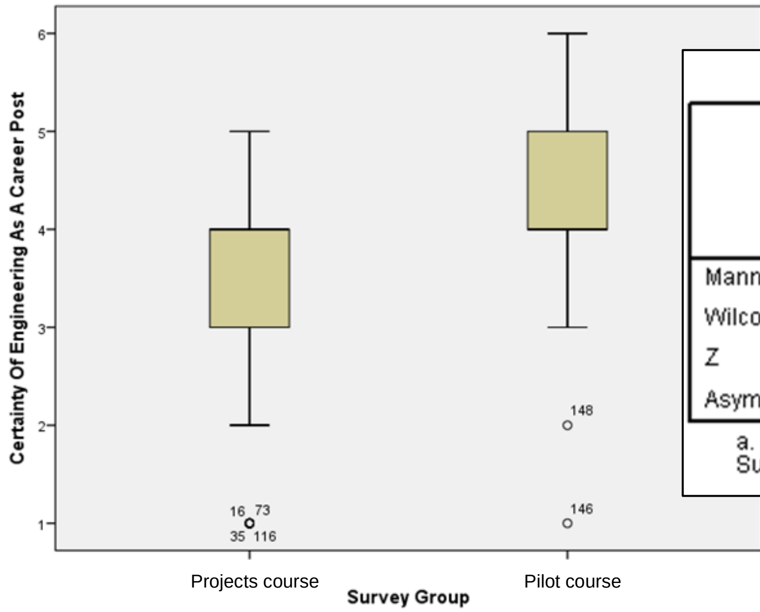


Test Statistics[a]

	FitInPost Fit In Well With Engineering Students Post
Mann-Whitney U	751.500
Wilcoxon W	11336.500
Z	-2.751
Asymp. Sig. (2-tailed)	.006

a. Grouping Variable: Survey Survey Group

Figure 5 Box plot for “I fit in well with engineering students”—post survey.



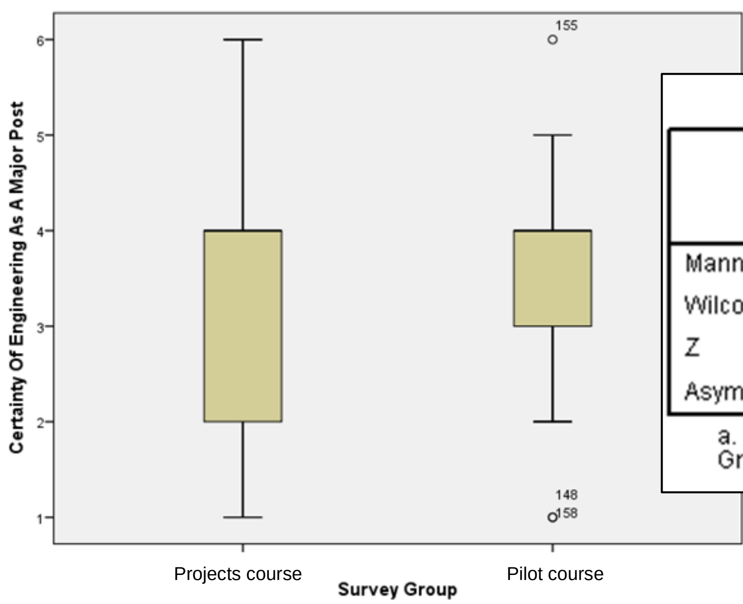
Test Statistics[a]

	Certainty CareerPost Certainty Of Engineering As A Career Post
Mann-Whitney U	894.500
Wilcoxon W	11479.500
Z	-1.953
Asymp. Sig. (2-tailed)	.051

a. Grouping Variable: Survey Survey Group

Figure 6 Box plot for “I am certain that I will have a career in engineering”—post survey.

Figure 7 indicates that by the end of the semester, there is more uncertainty in the projects course than in the pilot regarding students’ certainty of engineering as a major. The middle 50% of the projects course responses are between 2 and 4 (on a confidence scale from 1 to 5) and the upper and lower 25% span the entire confidence scale. On the other hand, for the pilot course the middle 50% of responses were between 3 and 4, and full range of 2 to 4 on the confidence scale. This result indicates that fewer female students in the pilot appear dissuaded from continuing an engineering major after experiencing the pilot course.



Test Statistics[a]

	Certainty Of Engineering As A Major Post
Mann-Whitney U	1205.000
Wilcoxon W	11790.000
Z	-.160
Asymp. Sig. (2-tailed)	.873

a. Grouping Variable: Survey Group

Figure 7 Box plot for “I am certain of my engineering major choice”—post survey.

Additional analysis, not reported here, included a comparison of the sense that the student felt as though they belong in engineering, and the sense of identifying with other engineering students.

Motivational Factors for Engineering Students and the Impact on Retention

The data are sourced from are fall 2010 (217 students) and fall 2011 (300 students) surveys. The fall 2010 survey contained data that identified who exited the engineering majors. The set of 18 questions in the section of the survey entitled “Tell us about your motivation” were grouped into four factors, using factor analysis. The factors are identified as intrinsic (internal enjoyment of the subject), extrinsic (contribution to society), mentoring, and monetary.

The initial analysis identified a difference between men and women in the influence of mentoring factor. The results show that women more often assign higher motivation value to mentors than do men. Men attribute the lowest rank (not a reason) to mentoring more often than women, while women assign the highest ranking (major reason) more often than men. The frequency of the highest ranking (major reason) in the complete data set is 10%, while women choose it twice as often (a bit under 20%).

Searching for a link between motivation and retention students who left engineering are compared to those who stayed. The sample set of the students who left and who were in the initial survey was not large (37 students) compared to the overall number of students (217) in the survey for 2010 so a normalized frequency analysis was used to compare motivation factors between those two sets. Two differences are evident, one in the extrinsic motivation, which encompasses questions that have to do with making a difference in the world with engineering, and the other is the monetary factor. The students who exited after their first year had a lower rating when it came to making a difference in the world with engineering. On the other hand they rated the monetary factor higher.

The plot in Figure 8 shows that students who left the College less frequently chose the highest ranking in their motivation (major reason) for the extrinsic factor (making the difference in the world). In the complete sample the percentage of students who have chosen the highest ranking is 50%, while for the “leavers” subgroup it is closer to 35%. Conversely, the students who left gave the factor “make the difference in the world” twice as often the lowest ranking of (not a reason). Only 5% of the overall population gave this factor the lowest ranking while 10% of the students who left did so.

The monetary reason has much stronger influence on students who left the major than the ones who stayed. From Figure 8 we observe that the students who dropped left have a considerably higher percentage of the highest ranking (major reason) and none at all of the lowest ranking (not a reason). In the whole sample the percentage of students who gave monetary factor the highest ranking is 30% but for the students who dropped it is 40%.

From these observations we can draw a couple of policy conclusions. The first is that women who stay in engineering are more often motivated by mentors. A policy recommendation from this conclusion is that to retain women, the College should provide mentors to female students.

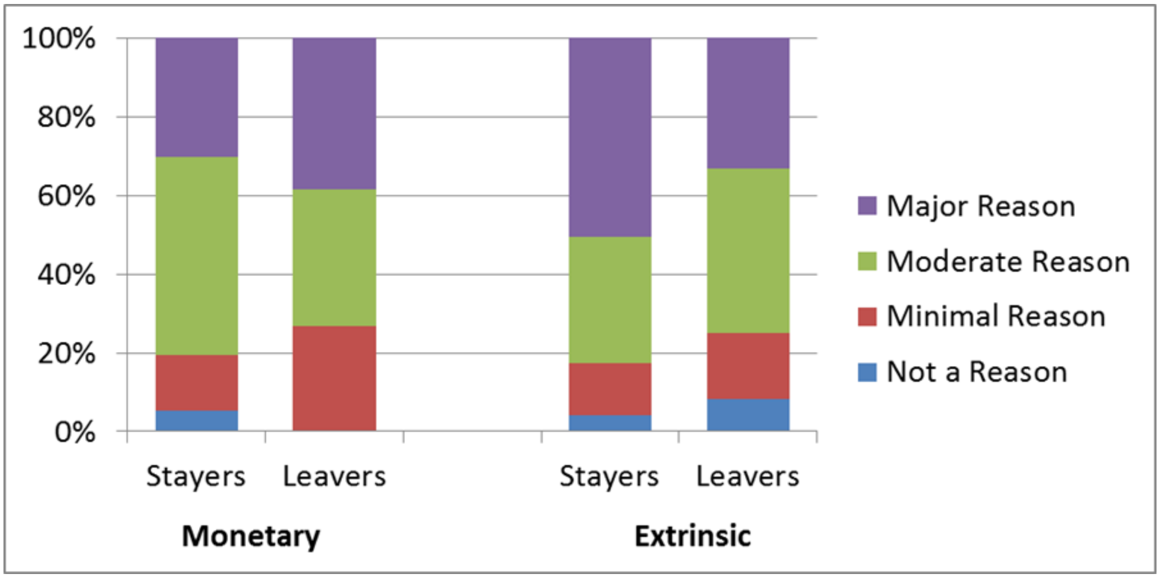


Figure 8 Factor influencing the decision of "stayers" and "leavers" in the College.

The students who stay in engineering appear to value the ability to "make the difference in the world" more than students who leave. On the other hand, the leavers appear more motivated by monetary reasons. Policy implications are more difficult to establish in this case, but a parallel emphasis societal impact of engineering, with a positive spin on the monetary aspects of the profession, appears to be a reasonable policy recommendation.

Summary

In response to enrollments growing faster than available resources, the College implemented a policy to limit enrollments for specific majors. Unexpected consequences of the policy initiated a discussion about the entire first-year experience that created an opportunity to visit the pedagogical goals of the first year, including the impact on retention, as well as coping with growing enrollments with stagnant resource availability. A task force of department and program chairs was formed and their assessment and recommendations was supplemented by feedback from college-wide workshops. As part of a comprehensive overhaul of the first-year experience, a new introduction to engineering course is planned to replace the current introduction-to-major courses. The pilot was built from an existing course, that was designed primarily for first-year students matriculating into the OPEN option. The structure of the course was presented, and results of pre- and post- survey data, and anecdotal observations from the instructor readings of the students' essays are reported.

To support the new first-year course and the College's broader effort to assess the experiences of first-year students, four studies were conducted by graduate research fellows funded through the Center for the Integration of Research, Teaching, and Learning (CIRTL). These studies are aligned with course objectives and focused on first-year experiences, and the factors that influence students' decisions to be a "stayer" in a major or the College, or a "leaver" from the College or the University, students' attitudes towards the profession, and some insight into students' perceptions of the Student Honor Code.

Conclusions

The results of the pre- and post- surveys indicate that the Introduction to Engineering pilot was significantly successful in increasing students' knowledge of the engineering profession. Given that 84% of the registered students were OPEN, the decrease in the fraction of students who indicated their intention to complete an engineering major, and certainty of a major or career choice, was not surprising. Again, Course Objective 1 and 2 are to "discover the engineering profession" and to "introduce the College's disciplines and majors," with the expected outcome that students will be empowered to make an informed major selection decision.

There was no evidence that the pilot had much effect on the historical choice of mechanical engineering as the most likely major choice. The instructors believe that this is based on the preconception that mechanical engineering is a much more broad discipline than the others, thus maximizing career opportunities. Unfortunately, this question was not addressed in the pre-post survey analysis, and will be the focus of future study.

The CIRTL-sponsored TAR projects addressed several questions important for determining influences on the choice of major made by first-year students, as well as factors that ultimately influence career choice. The results reinforce the need for lessons that illustrate how engineers make relevant contributions to society, with the concomitant need to explore just what does it mean to contribute to society—there are many philosophical issues here. This is reinforced with the findings that students who stay in engineering are more motivated by the opportunity to make a difference in the world than those who leave. The need to provide more Honor Code orientation is also evident.

Based on the outcomes of the pilot course, and the parallel study of overall first-year experience, it is decided that the pilot course will be repeated in fall 2012 as a 2-credit course. Even before the semester was concluded, it was obvious to the instructors, that the course objectives just could not be satisfactorily met in a one-credit course. Along with other lessons learned from the pilot, a 2-credit course will give more opportunity to revisit topics and concepts for an improved learning experience. Of course this requires that the departments and programs make some small curriculum or requirements changes to accommodate the shift of an additional credit to the Introduction to Engineering course. The need is also apparent for a more comprehensive review of the course content to ensure that ABET-related topics covered in the current introduction-to-discipline are covered in the new course. In additions to employing lessons learned to improve the 2-credit pilot, lessons learned for appropriate assessment will also be implemented.

Acknowledgements

The authors acknowledge the contributions of the GEEN 1500 Module Instructors: Angela Bielefeldt, Michael Brandemuehl, Anne Dougherty, Dirk Grunwald, Charles Rogers, Clayton Lewis, Michael Lightner, Shelly Miller, Adam Norris, Harihar Rajaram, James Voss, and members of the GEEN 1500 Design Team: Amelia Finau-Starkey, Stephanie Rivale, Mary Steiner, Jacquelyn Sullivan, and Lori Walker. We also acknowledge Laura Border for CIRTL support.

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