

## **Assessment of a First-Year Introduction to Civil and Environmental Engineering Course**

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### **Introduction**

The freshman year for an engineering student is critical to his or her retention in an engineering program. The typical first-year engineering curriculum in the US contains a rigorous workload of science and mathematics courses, along with two or three courses in the humanities. Often, the only exposure to engineering that students obtain in this first year is in an introductory engineering course.

The purpose of this paper is to summarize the efforts by the University of Wisconsin-Platteville (UWP) Department of Civil and Environmental Engineering to improve the freshman engineering experience. Specifically, we have focused on the introductory engineering course.

This work was funded by the National Science Foundation Course, Curriculum, and Laboratory Improvement (CCLI) Adaptation and Implementation (A&I) program. We adapted the “Sooner City” concept from the University of Oklahoma (OU). Sooner City is a “virtual city,” and was created to enable OU to incorporate “design across the curriculum,” in which all CEE courses have a design component that builds on designs created in previous courses<sup>1</sup>. Students use this virtual city to design a variety of civil engineering projects. For example, students in a geotechnical engineering course can obtain soil characteristics data from the program and use that information to design a building foundation. In a structural engineering class following this, students design the structure that will be supported by this foundation.

Our adaptation of the Sooner City concept was to take the design across the curriculum concept and apply it to the first-semester introductory engineering course. Rather than an entire city, freshmen would complete five design projects centered on a park on campus.

The goals of the project are:

- GOAL 1: Stimulate interest in engineering among freshmen;
- GOAL 2: Ensure that freshmen find the revised course “fun” yet challenging;
- GOAL 3: Enhance various “soft” skills such as time management, communication skills, teamwork, etc.;

- GOAL 4: Provide freshmen with an understanding of the breadth of the civil and environmental engineering profession;
- GOAL 5: Positively impact retention of freshman civil and environmental engineering students.

## **Background**

The University of Wisconsin-Platteville is one of the largest primarily undergraduate Civil and Environmental Engineering program in the U.S. Students initially enroll in the General Engineering program, and after successfully completing certain core requirements are matriculated in the engineering department of their choice. All students must take GE102 – Introduction to Engineering. This course was typical of many found in engineering departments in the US, and is accurately described by Ercolano<sup>2</sup> as “Sleep 101.” Students were not challenged and often did not feel that they had learned much about engineering upon completion of the semester.

## **Summary of Project**

More complete details of the revised GE102 course (referred to in the remainder of this paper as ICEE – Introduction to Civil and Environmental Engineering) can be found in Parker and Anderson<sup>3</sup>. Freshmen who registered in the summer that had declared a civil or environmental engineering major were placed in the ICEE sections. The courses ended up containing approximately 2/3 to 3/4 civil and environmental engineering students.

ICEE has five modules corresponding to the five traditional emphasis areas in civil and environmental engineering: construction; environmental; geotechnical, structural, and transportation. The course is project based, and students complete a project for each of the modules. Each module’s project was based on a component of a park on campus. For this park, students designed a parking lot to serve the park; designed a detention pond to capture runoff from the parking lot; designed a modular block retaining wall to provide level space for the parking lot; designed a pedestrian bridge for visitors to cross the stream; and created a construction schedule and cost analysis. Half of the projects were completed in teams and all projects culminated in a final written report and oral presentation.

## **Assessment Process**

The ICEE course was first offered in the Fall semester of 2002. We assessed this course in a number of ways. We began the semester by administering an entrance survey to the two ICEE sections and to six GE102 sections. The GE102 sections are the traditional introductory engineering course and the ICEE sections are those that we have created through this project. In the last two weeks of the semester, we administered an exit survey.

The entrance survey and exit surveys were distributed to the two ICEE sections (total of 70 students) and six GE102 sections (total of 176 students). The six GE102 sections acted as our “control” sections. The purpose of the entrance survey was to a) determine why students decided to pursue engineering in the first place; b) assess student confidence in obtaining an engineering

degree; c) evaluate student attitudes toward engineering. The purpose of the exit survey was to evaluate a) student attitudes toward engineering and b) students perception of the learning gains made in their introductory engineering experience.

## Findings

In this section, we present a summary of the more interesting findings from our assessment.

*Finding #1: Students enjoyed ICEE more and found it more challenging than the GE102 sections.*

As shown in Table 1, we solicited answers from students concerning their enjoyment and level of challenge in several ways on the exit survey. Note that the percentages shown in the Table 1 and in all subsequent tables represent the sum of the “Agree” and “Strongly Agree” responses to the survey statements.

**Table 1**

Statement	GE102 n = 177	ICEE n = 71	p
This course was challenging	29.9%	61.4%	4.31E-6
I enjoyed this course	64.4%	72.9%	0.201
I feel that this course was a waste of time	35.0%	20.0%	0.020
This course contains too much busy work	35.6%	45.7%	0.139
This course was “fun”	63.8%	74.3%	0.114

*Finding #2: ICEE made a greater positive impact on soft skills.*

The traditional GE102 course had several lectures devoted to discussing team work skills, time management, etc. Our philosophy in creating the ICEE course was that these skills could best be learned by having students complete realistic projects that would require these skills in order to be effectively completed. Results from the exit survey concerning the impact of the courses on soft skills are shown in Table 2.

**Table 2**

<b>Question</b>	<b>GE102 n = 177</b>	<b>ICEE n = 71</b>	<b>p</b>
The course had a positive effect on my...			
Problem-solving skills	56.5%	77.1%	0.002
Study skills	45.2%	72.9%	0.000
Teamwork skills	83.1%	90.0%	0.165
Time management skills	59.9%	77.1%	0.010
Writing skills	42.4%	54.3%	0.089
Speaking skills	55.4%	57.1%	0.799
Computer skills	65.5%	75.7%	0.119
Appreciation of the role of engineers in society	80.8%	87.1%	0.233

*Finding #3: Interestingly, the positive benefits of the course have not translated to higher retention rates.*

Revisions to the introductory engineering course at other universities have appeared to positively impact retention. For example, in Hoit and Ohland's<sup>4</sup> new laboratory-based introductory engineering course, 100 of the 198 students were retained as compared to 111 of 321 in the "control" lecture sessions. Although we are dealing with smaller sample sizes, we do not have any evidence that the type of introductory engineering course (ICEE vs. GE102) has an impact, positive or negative, on freshman retention. 55 of the 84 students (65%) enrolled in ICEE were retained in the College of Engineering, Mathematics, and Science while 155 of the 220 students (70%) enrolled in GE102 were retained.

We are unsure why this course that was viewed more positively in terms of enjoyment and the amount of challenge would not positively impact retention. The first thought is that one course cannot be expected to make a significant difference, given the many other variables that come into play when examining retention.

We also investigated whether the students' attitudes at the start of the semester and their reasons for choosing to study engineering varied significantly between the two sections. Table 3 shows results from the entrance survey, administered during the first week of the semester. It clearly shows that students in the ICEE sections were more confident (although not significantly so) than their peers in the GE102 sections.

**Table 3**

Statement	GE102 n = 177	ICEE n = 71	p
I am confident that I am able to obtain an engineering degree from UWP.	95%	97%	0.96
I am sure I want to be an engineer.	82%	85%	0.83
I plan on continuing my studies in engineering	91%	97%	0.93

Next we asked questions to assess whether the students' reasons for entering engineering in the first place were based on the "right" reasons. We based these questions on the work of Seymour and Hewitt<sup>5</sup>, and provided the questions to students on the entrance survey. "Right" reasons might include a history of being interested in how things work while "wrong" reasons might be choosing engineering based on feeling "pressure" to do so. Other reasons (e.g. excelling in math and science in high school) could be argued either way; we don't want excellent math skills to be the only reason that students enter engineering, yet we recognize that a high proficiency in mathematics is a strong indicator of success in engineering. Table 4 lists results from these statements.

**Table 4**

Statement	GE102 n = 177	ICEE n = 71	p
I have always been interested in how things work.	95%	97%	0.511
I have always enjoyed "tinkering" and building things.	96%	94%	0.599
Family or friends actively encouraged me.	78%	82%	0.500
Starting salaries in these fields are relatively high.	90%	96%	0.147
I felt pressure to pursue a technical degree.	16%	14%	0.709
The job market in these fields is generally healthy.	85%	81%	0.408
I excelled in math and science in high school.	95%	88%	0.021
I wanted to make a difference in people's lives.	73%	81%	0.183

Two items stand out to us. Students in the ICEE sections were more apt to list starting salaries as a reason for pursuing engineering. This finding, combined with ICEE students' lower self-reported math and science abilities may help to explain differences in retention.

*Finding #4: Students perceived abilities do not agree with reality*

When asked on the entrance survey and the exit survey whether they were capable of obtaining an engineering degree from UWP, the students overwhelmingly felt they were able. Interestingly, the results did not change appreciably from the start of the semester to the end of the semester (see Figure 1). This finding is surprising, given that only 65% of them were actually retained 1 year later, and given the historically low passing rate in lower level Mathematics courses at UWP.

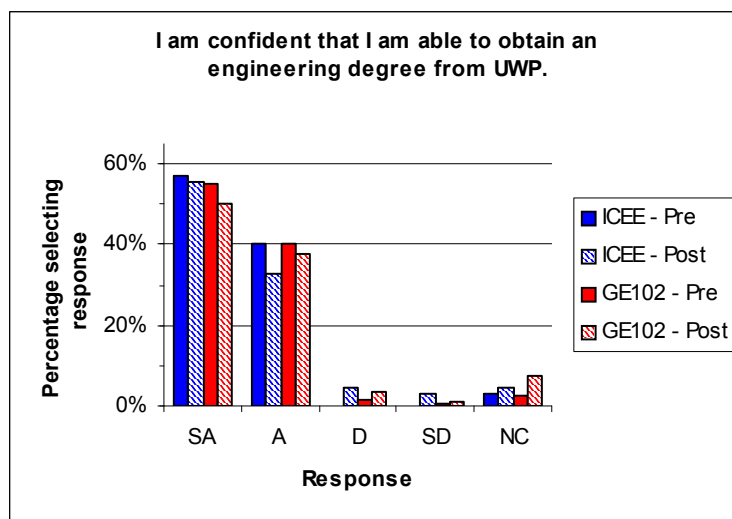


Figure 1

*Finding #5: Gender differences*

There were no significant differences on the entrance survey between men and women. This in itself is an interesting finding based on the variety of questions asked.

However, several differences did show up on the exit survey. Moreover, the significant differences varied between the GE102 and ICEE sections; we will treat them separately in this section.

Table 5 illustrates the differences for the ICEE sections. Note that less of the women enrolled in ICEE sections were sure they knew what engineers did and planned to continue in engineering.

**Table 5**

Statement	Male (n=63)	Female (n=8)	p
I am sure I want to be an engineer.	89%	25%	1.1E-05
I feel I know what an engineer does.	97%	63%	3.5E-04
I plan on continuing my studies in engineering	90%	50%	1.9E-03
I am excited about my career choice	94%	75%	7.4E-02

Table 6 illustrates the differences for the GE102 sections. Women in GE102 overwhelmingly felt that the course required too much busy work and was not challenging. However, this is partly contradicted by the fact that less women than men thought the course was a “waste of time”

**Table 6**

<b>Statement</b>	<b>Male (n=159)</b>	<b>Female (n=18)</b>	<b>P</b>
This course was challenging	33%	6%	1.7E-02
I enjoyed this course.	67%	44%	6.2E-02
I feel that this course was a waste of time.	37%	17%	8.5E-02
As a result of this course, I am convinced that I do not want to be an engineer.	3%	11%	5.6E-02
This course contains too much “busy work.”	31%	72%	6.2E-04

### **Status of ICEE at UWP**

The creation of the new ICEE course was viewed with mixed reactions by UWP faculty. Some viewed the changes in a positive light, and were happy to see changes being made to a moribund course. Some viewed the revised course with some negative feelings, seeing it as an attempt by a single department to “take over” a course previously offered by the General Engineering Department. Perhaps due to both of these outlooks, the College of Engineering, Mathematics, and Science (EMS) created a task force to investigate changing the GE102 (Introduction to Engineering) course (it was this course that the ICEE course was replacing for Civil and Environmental Engineers).

The Task Force decided to create two new 1-credit courses from the existing 2-credit GE102 course. The new courses (GE100 – Introduction to Engineering and GE103 – Engineering Projects) were designed to address the shortcomings of the existing GE102 course that were the impetus for the creation of the ICEE course in the first place.

Specifically, the new GE100 (Introduction to Engineering) covers the following topics:

- University Computer System (1 period)
- Intro to Engineering Disciplines/teamwork (3 periods)
- Graphing by hand (1 period)
- Library (1 period)
- Study Skills/Time Management (1 period)
- Excel/ Word (2 periods)
- Significant Figures/Units/Dimensions (1 period)
- Presentation skills/ PowerPoint (1 period)
- Engineering Ethics (1 period)
- Registration/Advising/General Ed Requirements (1 period)
- Career Exploration/Co-op (1 period)
- Solution of Simultaneous Equations using a Graphing Calculator (1 period)

In the second 1-credit course (GE103 Introduction to Engineering Projects), students will complete four inter-disciplinary engineering projects. Examples include creating a timing

system for a traffic signal (electrical engineering and civil engineering) and materials testing (civil engineering and mechanical engineering). The following skills and knowledge will be emphasized in the projects:

- Report Writing
- Presentation Skills
- Spreadsheet Skills
- Data Collection/Analysis - spreadsheet analysis, drawing valid conclusions
- Engineering Ethics
- Engineering Calculations
- Further Exploration of Engineering Disciplines
- Team/Group Work

In addition to the benefits mentioned previously, this new course sequence will introduce all of the engineering disciplines offered at UWP to all first-year engineering students. The GE100 course will introduce students to the various engineering careers, and the GE103 course projects will include interdisciplinary projects.

One drawback to the new course sequence is that the ICEE course will no longer fit within this framework. The ICEE course is a two-credit course that focuses on civil and environmental engineering. The new courses are spread across two semesters, and the underlying philosophy is that first-year students need exposure to the various engineering disciplines, and that focusing on a single discipline would be a disservice to the students and to the engineering programs that are traditionally unknown by the students (e.g. Industrial Engineering, Engineering Physics).

## Bibliography

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<sup>2</sup> Ercolano, V. "From Sleep 101 to Success 101," *ASEE Prism*, September 1995.

<sup>3</sup> Parker, P.J. and Anderson, M.L. "Creation of a Project-Based Introduction to Engineering Course." ASEE Annual Conference, Nashville, TN, June 22-25, 2003. (Published on CD-ROM).

<sup>4</sup> Hoit, M. and M. Ohland. "The impact of a discipline-based introduction to engineering course on improving retention," *Journal of Engineering Education*, 87(1), p. 79-85, 1998.

<sup>5</sup> Seymour, E. And Hewitt, N.M. (1996). "Talking About Leaving: Why Undergraduates Leave the Sciences," Westview Press.



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