Creation of an Introduction to Engineering Course based on the "Civil City" Concept

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Session #2793

1 Introduction

The freshman year for an engineering student is critical to the retention of that student. 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. We have developed an introductory engineering course that effectively engages the first-year student by introducing him or her to engineering design through five design projects.

Specifically, the goals of the project are to:

1) Create a "portable" first year Introduction to Civil and Environmental Engineering (ICEE) course based on the Sooner City program.
2) Assess the success of the ICEE course at meeting the following global objectives:
   a) Stimulate interest in engineering among freshmen;
   b) Provide freshmen with an understanding of the breadth of the civil and environmental engineering profession;
   c) Positively impact retention of freshman civil and environmental engineering students.
3) Provide course materials on a web page to facilitate implementation of the course at other universities.
4) Beta test the ICEE course at another university.

In this paper, we discuss the course we have created and the results of the first steps in our assessment process.

2 ICEE Course Description

The new course we have created 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

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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.

3 Educational Materials

For each module, we created the following educational materials.

1. We created "board notes" for each lecture of the semester. These board notes are our lecture material, and are modeled after the format provided at the American Society of Civil Engineers (ASCE) ExCEED (Excellence in Civil Engineering Education) workshop. Board notes have two distinctive attributes that make them distinctive as compared to traditional lecture notes. First, they start out with learning objectives. Second, the paper on which board notes are written is divided into squares, in which each square represents a space of chalkboard (or whiteboard) which will be filled with those notes.

   The board notes we created are complete for the entire semester, and have notations on them for questions to ask the students, reminders, other points of interest, etc. Also, we noted throughout the semester which lectures were rushed and which could present more material. These notes will be revised for the coming Fall semester when the ICEE course will be taught a second time. We feel that we have created a set of notes that can be readily adapted by faculty at other universities.

2. Each module began with a PowerPoint presentation, delivered by a faculty member with expertise in the corresponding emphasis area. These presentations provided students with an overview of each sub-discipline, and provided many photographs of relevant engineering designs and projects. Photographs ranged from large world-wide projects, but we also made sure to include pictures of local and regional examples so students could readily relate to the examples. For example, pictures of famous bridges were included in the Structural Engineering presentation, but we also included pictures of local truss bridges and other local structures of interest. These PowerPoint presentations were viewed with much interest by the students, and we feel that they are extremely important in capturing the interest and hopefully can motivate the students to continue in their studies.

3. Nearly every class period had a corresponding homework assignment, and the assignment handouts are all in Microsoft Word format. We have created solutions for these homework assignments, and will prepare neat typewritten solutions in Year 2 of the project.

4. Each module culminated in a project. Half of the projects were performed in teams, and half were performed as individuals. This gave students valuable experience with team work, yet the individual projects provided us with information to better assess each individual student's learning. Moreover, the grading load was reduced for the team

reports. Each module culminated in an oral presentation also. Only two groups gave a presentation for each module. This spread the oral presentations throughout the semester, thus saving the tedium of several consecutive days at the very end of the semester devoted to oral presentations. Moreover, each student gave a total of two presentations throughout the semester.

The module projects are summarized below.

a. The semester began with the transportation engineering project. Students were provided an aerial photograph and topographic map of the park and surrounding area, and instructed to design a parking lot to serve the park. Students needed to determine the size, exact location, and stall layout. Other outcomes consisted of drawing the lot to scale on the map and drawing a cross section through the parking lot.
b. The environmental engineering project involved designing a stormwater detention pond for the parking lot. Students needed to calculate the excess runoff generated by the proposed impervious surface of the parking lot, and size and locate the pond.
c. Most of the parking lots were built into the side of a hill on campus. The geotechnical engineering project for this course involved designing a retaining wall for the parking lot such that more flat and useable space was made available. Students were provided with a manufacturer's design tables, and needed to select a block type, determine the number of blocks required, select a type of backfill material, and quantify the volume of fill required.
d. The West Point Bridge designer was used for the structural engineering module project. Students designed a pedestrian bridge across a stream near the previously designed parking lot.
e. For the construction engineering module, students designed a Critical Path Model (CPM) for scheduling the project tasks and also used Precision Estimating software to estimate the construction cost of the parking lot.

4 Web Page

All of the materials related to this project will be available on the project web page (http://www.uwplatt.edu/~ce/icee/). This will allow faculty at other institutions to download board notes, assignments, projects and exams with solutions, and PowerPoint presentations on sub-discipline overviews. These pages will be password protected so students cannot access solutions. Students will be able to access assignments, syllabus, explore hypertext links to relevant sites, access data files, etc. Other documents that we have written to assist students are also available, such as information on using PowerPoint, writing engineering reports, etc.

Currently, the webpage is in development, but includes much of the information listed above in "rough" format.

5 Implementation of Educational Materials

Although we had originally proposed teaching a single course of ICEE during the Fall 2002 semester, Dr. Anderson volunteered to teach an additional section of the course as an overload teaching assignment. This second section provided us with additional valuable insight on our students' learning.

Forty students were enrolled in each section. Students were enrolled in a variety of mathematics courses, ranging from remedial algebra to Calculus and Analytical Geometry II. This represented a significant challenge in creating the homework assignments.

During the registration process for this course, we informed the registrar to only allow declared civil or environmental engineering students in these two sections. However, our instructions were not fully carried out, and we ended up with a mix of students. Dr. Parker's section contained 30 CEE students while Dr. Anderson's contained 20 CEE students.

6 Assessment Methods

We are assessing this course in a number of ways. We began the semester by administering an Entrance Survey to both 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.

The Entrance Survey is provided in the Appendix. With this survey, we were attempting 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. By compiling the data from all eight sections, we have an excellent profile of the freshmen entering engineering at UWP.

Data from the Entrance Survey will be compared to results from the Exit Survey, submitted to all eight sections. The Exit Survey was administered during the last two weeks of the semester. This survey is also in the Appendix, and includes some of the same questions as were contained in the Entrance Survey (e.g. "I am confident that I am able to obtain an engineering degree from UWP"; "I am sure I want to be an engineer"). Other questions are aimed at uncovering student satisfaction with the various sections of the introductory engineering course.

Data has been compiled and analyzed from the Entrance Survey and has been compiled but not analyzed for the Exit Survey.

Other assessment measures include the departmental course evaluation form filled out by students for all CEE courses and our impressions made through personal observations, performance on the final exam, and student feedback.

7 Assessment Results

In this section, we report on the results from the Entrance Survey, discuss the direct feedback from students, and relate our personal impressions after teaching the course, and

7.1 Entrance Survey results

The Entrance Survey was completed by 269 students enrolled in two ICEE sections and six GE102 sections. The male:female ratio was 89%:11%. The declared majors of these students is shown in Figure 1. Note that 20% of the students are enrolled as "General Engineering" majors or are otherwise undecided; this represents the second largest group of respondents.

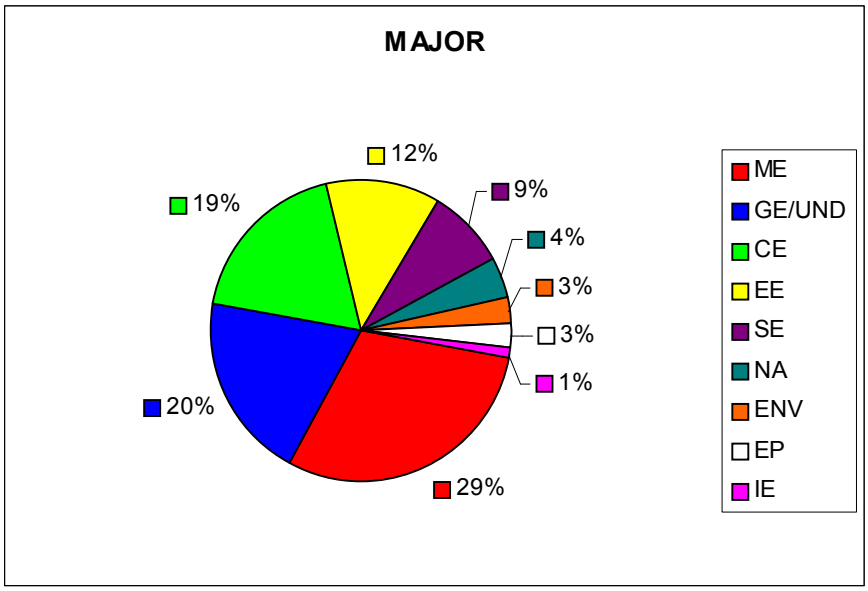

Figure 1

The first set of questions were asked to determine the reasons these first-year students had chosen the engineering field in the first place. These questions were directly inspired by the work of Seymour and Hewitt in "Talking About Leaving." Based on Seymour and Hewitt's work, we included "appropriate" and "inappropriate" reasons for choosing engineering, where "appropriate" reasons included encouragement of family and friends and the desire to make a difference in people's lives. "Inappropriate" reasons included an interest in high starting salaries and excelling in math and science in high school. Eventually, these results will be correlated to student retention in engineering.

Nearly all respondents (96%) cited an interest in how things work as a reason for pursuing engineering and the same fraction agreed that they have always enjoyed "tinkering" and building things. A large fraction (91%) also cited the fact that they excelled in math and science in high school as an influence on their decision to pursue an engineering degree.

The impact of family and friends has a large influence on students' career choice. Nearly 80% of the respondents noted that they had been actively encourage by family and friends to pursue engineering. This fraction was nearly identical for men and women (79.2% and 79.4% respectively). In a separate but related question, 15% of all respondents either "strongly agreed" or "agreed" with the statement "I felt pressure to pursue a technical degree."

Other results from this portion of the survey indicated that 93% of the respondents excelled in math and science in high school and that 74% either agreed or strongly agreed with the statement "I wanted to make a difference in people's lives."

The differences in responses for this first portion of the survey in terms of gender are explored in the following table. The value under the "male" and "female" headings refers to the proportion of the respondents who agreed with the statement. This proportion represents those who either "strongly agreed" or "agreed" to the statement on the survey.

Statement	Male	Female	*p*
I have always been interested in how things work.	97%	86%	0.005213
I have always enjoyed "tinkering" and building things.	97%	86%	0.009961
Family or friends actively encouraged me.	79%	79%	0.985638
Starting salaries in these fields are relatively high.	91%	97%	0.325068
I felt pressure to pursue a technical degree.	15%	21%	0.387492
The job market in these fields is generally healthy.	15%	21%	0.387492
I excelled in math and science in high school.	84%	79%	0.504237
I wanted to make a difference in people's lives.	84%	79%	0.504237

These results show that male students were significantly more likely to have selected engineering because of their interest in how things work and their enjoyment of "tinkering" and building things. However, it is important to note that 86% of women respondents agreed with this statement.

The fact that both women and men cited encouragement from family and friends to an equal amount is encouraging. This may provide evidence against the stereotype of women being discouraged to enter a "masculine" field such as engineering.

We also found it interesting that more men than women (although not statistically significant) cited the reason of making a difference in people's lives as a reason for selecting engineering as a career choice. We had hypothesized that the opposite trend would occur, since women have been found to seek out "nurturing" roles in the workplace.

In addition to investigating the factors that impacted a student's decision to pursue engineering, the Entrance Survey assessed students' attitudes toward obtaining an engineering degree and opinions of the engineering profession. These results will be compared to students' attitudes and

opinions at the end of the semester, and will help us analyze how well the ICEE met its objectives and how it fared as compared to the GE102 sections. Thus, the results from this portion of the survey do not allow us to assess the ICEE course, but are included in this annual report for the sake of completeness.

Perhaps the most interesting result from this survey is that 96% of all respondents felt that they were *able* to obtain an engineering degree from UWP and 93% planned on continuing their studies in engineering. This is an interesting result because historically about half of first semester students enrolled in engineering at UWP persist in engineering. This result may indicate that students seem to have an unrealistic opinion of their abilities and/or the demands of the engineering curriculum. Alternatively, they may simply be leaving engineering because they find that they do not enjoy it.

Other results from the second portion of the survey are tabulated in the following table.

Question	SA	A	D	SD	NC
I am sure I want to be an engineer	34%	49%	3%	0%	14%
I feel I know what an engineer does	17%	68%	7%	0%	8%
I excelled in math & science in high school	40%	54%	4%	1%	1%
I am excited about my career choice	41%	49%	1%	0%	9%
Engineering is a people-serving profession	24%	59%	3%	0%	14%
Engineers are boring	1%	3%	47%	42%	7%
Engineers don't need to write much in their jobs	0%	6%	54%	26%	14%

The differences in terms of gender are explored in the following table.

Statement	Male	Female	*p*
I am confident that I am able to obtain an engineering degree from UWP.	95%	97%	0.779733
I am sure I want to be an engineer.	95%	97%	0.779733
I feel I know what an engineer does.	95%	97%	0.779733
I enjoy reading.	95%	97%	0.779733
I enjoy writing.	58%	76%	0.057103
I excelled in math and science in high school.	45%	59%	0.178314
I plan on continuing my studies in engineering	93%	97%	0.421164
I am excited about my career choice	93%	86%	0.16704

Engineering is a *people-serving* profession	90%	86%	0.52751
Engineers are boring	81%	86%	0.513593
Engineers don't need to write much in their jobs.	5%	0%	0.23911

This table shows that there was virtually no differences in the expectations of women and men students in their attitudes toward the engineering profession and their expectations of receiving an engineering degree.

7.2 Student feedback

Several students enrolled in the ICEE course remarked to both Dr. Anderson and Dr. Parker that they had much more work than their friends did who were enrolled in the GE102 sections. We have carefully considered the amount of work that we are requiring, and feel that it is not overly burdensome. Indeed, a large number of students enrolled in GE102 in the past have commented that the course is not challenging.

Also, Dr. Parker noted that a few of the non-CEE students were disgruntled that the ICEE course only focused on civil and environmental engineering. We strongly believe that the education students received in our course on such topics as report writing, oral presentations, spreadsheet analysis of data, etc. was very valuable to all students regardless of discipline. Moreover, the GE102 sections most likely did not touch on every discipline of engineering, and did so in a cursory way, such as students giving presentations on an engineering discipline of their choice. In response to this, we allowed students to substitute a presentation on a discipline of their choice in place of one of the module design presentations. It is also important to note that several of the non-CEE students appeared to be very happy with the course and could see the relevance of the ICEE course to engineering in general.

7.3 Faculty impressions

In addition to the above assessment, we also made observations on the success of the class. We noted from lectures that we could not assume that *all* students could grasp even the simplest of topics without instruction. This was partly due to the fact that the majority of our past teaching has been to upper level students, but partly due to the great diversity of academic skills found in students enrolled in a first-semester introductory course.

We feel that students by and large "bought into" the class. Attendance was better than we expected for an introductory engineering course, and the majority of project reports were carefully and effectively written. Certainly there was a range in grades, but after students learned our expectation level, few students handed in unacceptably shoddy or incomplete work. Indeed, the only students who failed the course were those who failed to do the work at all.

Finally, we have no doubts that students enrolled in the ICEE sections worked much harder and learned a lot more than those enrolled in the other GE102 sections.

8. Summary

In summary, we have created an entirely new Introduction to Engineering course for civil and environmental engineers. The course has been successfully taught for one semester, and all materials will be available to instructors for free use.

Appendix

Introduction to Engineering Entrance Survey

The purpose of this form is to gather some background information on freshmen enrolled in the College of Engineering, Mathematics, and Science at UWP. This information will be used to give us a clearer picture of the types of students that are enrolled in our program.

1. Name (Optional*): _____

* Note that whether you provide your name or not, all results will be kept confidential

2. Section #: _____

3. Gender: __ M __ F

4. Declared Major: _____

5. Below is a set of statements describing factors that typically influence high school student=s decision to enroll in an engineering or science discipline. Indicate your degree of agreement with each statement by circling your category of response. Use the following marking scheme:

SA	=	Strongly agree
A	=	Agree
D	=	Disagree
SD	=	Strongly Disagree
NC	=	Not Certain

I decided to pursue an engineering degree because...

1.	I have always been interested in how things work.	SA	A	D	SD	NC
2.	I have always enjoyed "tinkering" and building things.	SA	A	D	SD	NC
3.	Family or friends actively encouraged me.	SA	A	D	SD	NC
4.	Starting salaries in these fields are relatively high.	SA	A	D	SD	NC
5.	I felt pressure to pursue a technical degree.	SA	A	D	SD	NC
6.	The job market in these fields is generally healthy.	SA	A	D	SD	NC
7.	I excelled in math and science in high school.	SA	A	D	SD	NC
8.	I wanted to make a difference in people's lives.	SA	A	D	SD	NC

PLEASE SEE OTHER SIDE

6. Below is a set of statements describing attitudes you might have toward engineering. Indicate your degree of agreement with each statement by circling your category of response. Use the following marking scheme:

SA = Strongly agree
A = Agree
D = Disagree
SD = Strongly Disagree
NC = Not Certain

a.	I am confident that I am able to obtain an engineering degree from UWP.	SA	A	D	SD	NC
b.	I am sure I want to be an engineer.	SA	A	D	SD	NC
c.	I feel I know what an engineer does.	SA	A	D	SD	NC
d.	I enjoy reading.	SA	A	D	SD	NC
e.	I enjoy writing.	SA	A	D	SD	NC
f.	I excelled in math and science in high school.	SA	A	D	SD	NC
g.	I plan on continuing my studies in engineering	SA	A	D	SD	NC
h.	I am excited about my career choice	SA	A	D	SD	NC
i.	Engineering is a *people-serving* profession	SA	A	D	SD	NC
j.	Engineers are boring	SA	A	D	SD	NC
k.	Engineers don't need to write much in their jobs.	SA	A	D	SD	NC

Introduction to Engineering Exit Survey

1. 1. Name (Optional): _____

* Please note that whether you provide your name or not, all results will be kept confidential.

2. Section #:
3. 3. Gender: __ M __ F
4. Major:
5. Below is a set of statements describing attitudes you might have toward engineering in general and toward this course specifically. Indicate your degree of agreement with each statement by circling your category of response. Use the following marking scheme:

SA	=	Strongly agree
A	=	Agree
D	=	Disagree
SD	=	Strongly Disagree
NC	=	Not Certain

a.	I am confident that I am able to obtain an engineering degree from UWP.	SA	A	D	SD	NC
b.	I am sure I want to be an engineer.	SA	A	D	SD	NC
c.	I feel I know what an engineer does.	SA	A	D	SD	NC
d.	I plan on continuing my studies in engineering	SA	A	D	SD	NC
e.	I am excited about my career choice	SA	A	D	SD	NC
f.	Engineering is a *people-serving* profession	SA	A	D	SD	NC
g.	Engineers don=t need to write much in their jobs.	SA	A	D	SD	NC
h.	This course was challenging.	SA	A	D	SD	NC
i.	I enjoyed this course.	SA	A	D	SD	NC
j	I feel that this course was a waste of time.	SA	A	D	SD	NC
k.	As a result of this course, I am convinced that I do *not* want to be an engineer.	SA	A	D	SD	NC
l.	This course contains too much Abusy work.@	SA	A	D	SD	NC
m.	This course was Afun.@	SA	A	D	SD	NC
g.	The course had a positive effect on my:					
	1. Problem-solving skills	SA	A	D	SD	NC
	2. Study skills	SA	A	D	SD	NC
	3. Teamwork skills	SA	A	D	SD	NC
	4. Time management skills	SA	A	D	SD	NC
	5. Writing skills	SA	A	D	SD	NC
	6. Speaking skills	SA	A	D	SD	NC
	7. Computer skills	SA	A	D	SD	NC
	8. Appreciation of the role of engineers in society.	SA	A	D	SD	NC