

# Promoting Self-Efficacy and Life-Long Learning in Conjunction with an Awareness of Contemporary Issues in Geotechnical Engineering

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**Abstract** – One of the major assignments in a senior level Geotechnical Engineering design course is that of a semester specialization – an individual project on a topic of the students’ choice related to geotechnical, geological, or geo-environmental engineering. This paper summarizes the various aspects of the semester specialization, discusses the evolution of the activity over a series of course offerings, and presents assessment of student performance of course objectives and program outcomes. The semester specialization is a project that can easily be adapted to a number of different courses with similar benefits as those shown in this paper.

*Keywords:* communication, ABET assessment, literature review paper, geotechnical engineering

## INTRODUCTION

Geotechnical Engineering II is a senior level design course that is the second in a two-course sequence, and is a required component of the Civil Engineering curriculum at Florida Gulf Coast University. The course focus is on the design and synthesis of information, and the primary topics covered are lateral earth pressure and retaining wall design, slope stability, and shallow foundation design including bearing capacity and settlement. Assessment mechanisms involve group projects, individual in class designs (exams), “roundtable” activities [1] and a semester specialization (essentially an individual project). Semester Specialization final deliverables: a review article of approximately 5000 words in a standardized template, a single page handout, and a 3 – 5 minute oral presentation; are built throughout the semester from a series of smaller assignments. These smaller assignments are designed not only to ensure that students are progressing at a reasonable rate, but also to incorporate both the editing process as well as a reflective piece into the assignment.

This paper focuses on the details and development of the semester specialization over four semesters of offering the course. Assessment of student performance of course objectives and program outcomes will be presented with emphasis on an ability to communicate effectively, recognition of the need for, and an ability to engage in life-long learning, and knowledge of contemporary issues, relating to ABET outcomes g, i, and j respectively. Student self-assessment of performance on related course objectives and program outcomes as well as feedback and evaluation of the activities will also be included.

## BACKGROUND

The U.A. Whitaker College of Engineering was established as a school of engineering at Florida Gulf Coast University in 2005, and transitioned to a college in the fall of 2011. Since graduating the inaugural class in spring of 2009 the three initial programs (Bioengineering, Environmental, and Civil Engineering) have all attained accreditation by the Engineering Accreditation Commission of ABET [2], the College has added and transitioned Computer Science to Software Engineering, and student enrollment in the four programs has risen to over 600. The Geotechnical Engineering II course has recently completed its fourth offering. Table 1 summarizes the semesters in

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which the course was offered, the number of students in the course, and the number of sections. To date sections have remained smaller than 30 students, however based on the continuing growth of the college it is likely that section sizes will increase.

**Table 1: Summary of Geotechnical Engineering II Course Enrollment**

| Semester    | Number of Students | Number of Sections |
|-------------|--------------------|--------------------|
| Spring 2009 | 14                 | 1                  |
| Fall 2009   | 28                 | 1                  |
| Fall 2010   | 48                 | 2                  |
| Fall 2011   | 43                 | 2                  |

The course is heavily project based, which effectively serves to address the mechanistic aspects of the learning outcomes (e.g. analyze and design rigid and flexible retaining walls and shallow foundations). Additionally, in this and other courses students have significant experience with technical report writing from both a laboratory experimentation results and a design results standpoint. However exposure to the technical writing of others (e.g. journal articles, conference proceedings – something outside of a textbook) is more limited. In conjunction with this, being required to evaluate the work of others, organize results from several works, and interpret how these results contribute in the larger scope of research is rarely performed. The intent of the semester specialization is to provide this opportunity to the students on a topic that is of particular interest to them in the hopes that it will serve to support the development of engineers who have the National Academy of Engineering Engineer of 2020 attributes including practical ingenuity, creativity, and lifelong learning [3] as well as those who are “master innovators and integrators of ideas and technology” as noted in the ASCE vision for civil engineering in 2025 [4]. Ultimately the goal is to increase student self-efficacy by transforming them from active to self-directed learners [5, 6].

### METHOD PROCESS

For the four semesters that the Semester Specialization (SS) has been implemented, the primary deliverables of a final paper, handout, and verbal presentation have remained the same. Additionally, the overall weight in the course of 30% has also been a constant. Things that have changed have been the preliminary deliverables, adjusted based both on feedback from students as well as to strengthen final submissions. In the second offering a 75% draft (rather than a 50%) was required to allow for greater feedback from the instructor prior to the final submission. In addition, the second offering also provided examples of handouts (from students in the first offering on topics not chosen in the second) to give a clearer idea on how to condense the information in an extensive paper into the limited space of a single page. The second iteration also included student to student feedback on the 75% drafts. The third semester added group discussions which created groups comprised of four students with two distinct topic areas to discuss progress. The fourth offering built on these group activities including 2 group discussions as well as student to student feedback and also included a movement in early submissions from article summaries to paper preparation (e.g. introduction and outline) as well as a draft of the handout with feedback (from instructor and students). An optional extra credit of a reflective essay on how SS has impacted self-directed and life-long learning may become a required component depending on the perceived value from the students and the instructor. These early submissions provide students with multiple opportunities not only to obtain feedback from the instructor on expectations, but also to become more familiar with the assessment mechanisms (e.g. the cut sheet for the final paper) by utilizing these items when evaluating classmate’s work.

### EVALUATION AND ASSESSMENT

This section discusses feedback obtained from student responses on end of semester surveys, as well as follow-up from students after graduation. In addition assessment of student performance with respect to three program outcomes of an ability to communicate effectively, a recognition of the need for, and an ability to engage in life-long

learning, and a knowledge of contemporary issues (corresponding to ABET outcomes g, i, and j, respectively) is presented.

### Student Evaluation of Learning Outcomes

At the conclusion of the semester, students are asked to evaluate their own ability to accomplish specific learning outcomes, as well as the course coverage of these learning outcomes. Table 2 summarizes student self-evaluation from the last three offerings for the following learning objectives: perform searches for reliable sources of engineering information (reliable info search), synthesize several sources into a cohesive summary of a topic relevant to geotechnical engineering (topic synthesis), and discuss various contemporary issues in geotechnical engineering (contemporary issues). Table 3 presents student evaluation of the course coverage of the same three learning objectives.

Table 2: Student evaluation of individual learning of course objectives

| Objective                   | Student Evaluation |     |     |              |     |     |          |     |     |                |     |     |
|-----------------------------|--------------------|-----|-----|--------------|-----|-----|----------|-----|-----|----------------|-----|-----|
|                             | Excellent          |     |     | Satisfactory |     |     | Marginal |     |     | Unsatisfactory |     |     |
|                             | '09                | '10 | '11 | '09          | '10 | '11 | '09      | '10 | '11 | '09            | '10 | '11 |
| <b>Reliable Info Search</b> | 89%                | 66% | 68% | 7%           | 24% | 29% | 4%       | 10% | 3%  | 0%             | 0%  | 0%  |
| <b>Topic Synthesis</b>      | 56%                | 51% | 59% | 44%          | 41% | 41% | 0%       | 5%  | 0%  | 0%             | 3%  | 0%  |
| <b>Contemporary Issues</b>  | 59%                | 68% | 65% | 37%          | 29% | 32% | 4%       | 3%  | 3%  | 0%             | 0%  | 0%  |

Response rates: Fall 2009 (27/28 = 96%), Fall 2010 (38/48 = 79%), Fall 2011 (34/42 = 81%)

Table 3: Student evaluation of course coverage of course objectives

| Objective                   | Student Evaluation |     |     |              |     |     |          |     |     |                |     |     |
|-----------------------------|--------------------|-----|-----|--------------|-----|-----|----------|-----|-----|----------------|-----|-----|
|                             | Excellent          |     |     | Satisfactory |     |     | Marginal |     |     | Unsatisfactory |     |     |
|                             | '09                | '10 | '11 | '09          | '10 | '11 | '09      | '10 | '11 | '09            | '10 | '11 |
| <b>Reliable Info Search</b> | 92%                | 72% | 61% | 4%           | 19% | 39% | 4%       | 9%  | 0%  | 0%             | 0%  | 0%  |
| <b>Topic Synthesis</b>      | 75%                | 69% | 71% | 21%          | 22% | 29% | 4%       | 9%  | 0%  | 0%             | 0%  | 0%  |
| <b>Contemporary Issues</b>  | 71%                | 88% | 84% | 29%          | 9%  | 13% | 0%       | 3%  | 3%  | 0%             | 0%  | 0%  |

Response rates: Fall 2009 (27/28 = 96%), Fall 2010 (38/48 = 79%), Fall 2011 (34/42 = 81%)

Both tables show the majority of students felt the course coverage and their ability in all three of these objectives was “Excellent”. Over the three offerings only 10% (at most) of the students believed course coverage and their ability to be “Marginal” or “Unsatisfactory”. As these objectives are for the entire course, it is possible that other course activities influenced student opinions of these results. For the contemporary issues objective in particular, the additional roundtable discussion forums held weekly in the class also have a direct impact. The reliable info search objective is more clearly related to the semester specialization as it required extensive time to identify both a relevant topic as well as appropriate articles to support that topic. Integrating these articles into a single semester specialization paper is a direct link to the topic synthesis objective, and the reason behind the establishment of this objective.

For the past two course offerings (Fall 2010 and Fall 2011) students were also asked to complete a Likert survey (1 = Strongly Agree to 5 = Strongly Disagree) providing feedback on select course activities. Survey results related to the semester specialization including the survey question, average response values and standard deviations are presented in Table 4. Response averages for all questions for both years fall closest to the “Agree” option, with results from the most recent offering more positive (and possessing a smaller standard deviation) for all questions. Students were closer to agree to neutral for the perceived value of the semester specialization, which also possessed the greatest standard deviation of the questions presented. Even with the neutral to slightly positive response to the value, students believe that the activities positively impacted their writing ability and allowed them to become knowledgeable on their specialization topic.

**Table 4: Student End of Course Critique for Semester Specialization activities including average (Ave) and standard deviation (SD) for Fall 2010 and 2011 (n = 38 & 34, respectively)**

| Survey Statement  | Fall 2010 |      | Fall 2011 |      |
|---|-----------|------|-----------|------|
|   | Ave       | SD   | Ave       | SD   |
| I am more comfortable searching for technical material after taking this course.  | 1.92      | 0.91 | 1.71      | 0.80 |
| I have increased knowledge of what resources are available for conducting literature searches after taking this course. | 1.86      | 0.75 | 1.71      | 0.80 |
| The semester specialization (SS) was a valuable part of the course.   | 2.41      | 1.28 | 2.24      | 0.92 |
| I believe the SS activities had a positive impact on my ability to write effectively.                                   | 2.14      | 1.18 | 2.00      | 0.92 |
| I consider myself to be knowledgeable in the area of my SS.   | 1.89      | 0.91 | 1.76      | 0.70 |

### Student Feedback

For the most part, students are interested in their topics during the semester, however most believe the semester specialization to be a significant amount of work, and (as noted from the Likert survey above) several question the true value of the assignment. However, a handful of students have mentioned the semester specialization (SS) in informal emails to the professor after graduation. These responses are presented below and demonstrate a much more positive response to the overall activity.

*“After my interview, I sent the president my SS. [...] After the president read my SS he sent me an email and said ‘I was impressed with your ability to deliver clear, concise thoughts, saying more with less. Well done.’ So thank you again.”* (Fall 2010 student currently working in Florida)

*“Remember my SS? I got to walk part of the levee today where the firm had done some work. But the new project I’m helping with is right near the failure that I did a case study on for my SS! [...] They requested a copy of my paper, and it had a lot to do with why they picked me over the other guy who had more experience!”* (Fall 2009 student currently working outside Florida)

*“By the way, I had a realization in which I now fully appreciate the experience of the Semester Specialization. It’s definitely a good prep for writing papers in grad school and doing lit reviews, which is essential. So if any of your Geotech students give you problems, you tell them I said it’s awesome!!!!”* (Fall 2010 student currently enrolled in graduate school)

While these are by no means the majority of the students, the fact that each of these individuals took the time to contact the instructor independently suggests that the long range impact of the semester specialization is a positive one.

### Course, Program and ABET Outcomes Assessment

As part of a continuous cycle of improvement, the Civil Engineering program outcomes are assessed on a yearly basis. This provides opportunities to identify areas which are particularly strong or weak and allows for adjustments to be made at the course and programmatic levels – all of which supports assessment for ABET evaluation. The Geotechnical Engineering II course utilizes both indirect means of assessment (such as the student feedback presented earlier) as well as direct means (student performance of outcomes measured against established benchmarks). Table 5 presents student evaluations from all four course offerings of the relative contribution the course has towards their attainment of three program objectives including: an ability to communicate effectively (communication), a recognition of the need for, and an ability to engage in life-long learning (life-long learning), and a knowledge of contemporary issues (contemporary issues) corresponding to ABET outcomes g, i, and j, respectively [7].

**Table 5: Student Feedback on Course Contribution to Select Program Outcomes**

| Program Outcome             | Course Contribution                                       |   |  |   |
|-----------------------------|---|---|--|---|
|                             | Spring 2009   | Fall 2009   | Fall 2010  | Fall 2011   |
| <b>Communication*</b>       | Large = 50%<br>Moderate = 43%<br>Small = 7%               | Large = 81%<br>Moderate = 19%<br>Small = 0%               | Large = 73%<br>Moderate = 24%<br>Small = 3%              | Large = 76%<br>Moderate = 21%<br>Small = 3%               |
| <b>Life-long learning</b>   | Large = 43%<br>Moderate = 36%<br>Small = 14%<br>None = 7% | Large = 67%<br>Moderate = 22%<br>Small = 11%<br>None = 0% | Large = 73%<br>Moderate = 22%<br>Small = 3%<br>None = 3% | Large = 62%<br>Moderate = 26%<br>Small = 12%<br>None = 0% |
| <b>Contemporary Issues*</b> | Large = 43%<br>Moderate = 43%<br>Small = 14%              | Large = 67%<br>Moderate = 33%<br>Small = 0%               | Large = 72%<br>Moderate = 22%<br>Small = 6%              | Large = 59%<br>Moderate = 32%<br>Small = 9%               |

\* No students indicated “none” for communication or contemporary issues. Response rates: Spring 2009 (14/14 = 100%), Fall 2009 (27/28 = 96%), Fall 2010 (38/48 = 79%), Fall 2011 (34/42 = 81%)

While only half of the students in the first offering felt the course had a large contribution to communication skills, the subsequent offerings all had almost  $\frac{3}{4}$  or more of the students with no more than one student in any year considering the course to have only a small contribution. The impact on life-long learning and contemporary issues is less dramatic, but with the exception of the first offering, a majority of the students believed the course to have a large contribution to these areas as well.

From an instructor standpoint, student performance on the relevant course outcomes and related program outcomes is very good. Table 6 presents the percentage of students by semester achieving various competency levels for course outcomes of performing searches for reliable sources of engineering information (reliable info search), and synthesizing several sources into a cohesive summary of a topic relevant to geotechnical engineering (topic synthesis). Highly competent is defined as 85% or better. Competent is defined as 70% or better, while minimally competent is defined as 65% or better.

**Table 6: Student Performance on Select Course Outcomes**

| Semester Offered | Reliable Info Search Competency  | Topic Synthesis Competency   |
|------------------|--|--|
| <b>Fall 2009</b> | Highly competent = 83%<br>Competent = 96%<br>Minimally competent = 96% | Highly competent = 74%<br>Competent = 100%<br>Minimally competent = 100% |
| <b>Fall 2010</b> | Highly competent = 85%<br>Competent = 94%<br>Minimally competent = 94% | Highly competent = 70%<br>Competent = 87%<br>Minimally competent = 91%   |
| <b>Fall 2011</b> | Highly competent = 80%<br>Competent = 95%<br>Minimally competent = 99% | Highly competent = 79%<br>Competent = 98%<br>Minimally competent = 98%   |

Overall the vast majority of students achieve at the highly competent level, with less than 10% not reaching at least minimal competency after course completion. Topic synthesis can also serve as a measure of assessment for the ability to communicate effectively, and thus can link directly to an assessment of that program outcome. The outcome of contemporary issues is directly assessed primarily through the roundtable activities rather than the semester specialization and for this reason results are not presented here. Spring 2009 results are unavailable as these particular course outcomes did not exist in the initial course offering.

## CONCLUSIONS

A semester long specialization project in a senior level engineering course can serve as a means of increasing student awareness in life-long learning and contemporary issues as well improving their communication and life-long learning skills. The open ended topic choice increases student interest and the final deliverables instill a sense of self-efficacy in many students. Feedback from students suggest that while the project is complex and time intensive, it does serve to support several course and program outcomes and relate to three of the more “professional skills” focused ABET outcomes. In particular, students discover the value of the semester specialization after completion of the course. Because of the open ended nature of the topic choice, the project can easily be incorporated into a variety of courses; although depending on the level of complexity of the required readings, the project may be more effective at the higher (Junior/Senior) levels. In larger class sizes teams or groups can also be created, however the effectiveness of this has not currently been evaluated.

## REFERENCES

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