AC 2010-944: DEVELOPMENT AND ASSESSMENT OF A REVISED INTRODUCTORY ENGINEERING COURSE

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Development and Assessment of a Revised Introductory Engineering Course: Work in Progress

Introduction

GE1030 (Introduction to Engineering Projects) is required of all engineering students at the University of Wisconsin-Platteville, and is taken by most students in their second semester. Students who enroll in engineering at the University of Wisconsin-Platteville enter the General Engineering Department, and do not matriculate into the degree-granting programs until they have satisfied certain requirements. Thus, students have from two to four semesters before they need to finalize a decision on which engineering major they will pursue. Consequently, the importance of GE1030 is obvious in the eyes of many faculty, given that the objectives of the course are to introduce students to the seven engineering disciplines available at the university and to inspire them to continue in engineering.

In recent years, anecdotal evidence suggested that this course was not meeting its objectives. Some faculty members complained that the course was not rigorous enough and that students found it "useless." Consequently, some of the engineering programs proposed dropping GE1030 as a required course. A committee was formed in response to this and countered with a revised course. The programs that had threatened to drop the course adopted a "wait and see" attitude. If the modified course represented a significant improvement over the old course, these programs would continue to require the course.

This paper describes the modified course and presents preliminary assessment results that address the question: have the modifications worked? That is, does the revised course (hereafter referred to as the "new course") meet its objectives better than the original course ("old course")?

Background – The Old Course

The old course was created for the Fall 2004 semester. It had a prerequisite of General Engineering 1000 - Engineering Success Skills and was a one-credit course that met once a week for a 52-minute period. From Fall 2004 until Spring 2009, the enrollment for GE 1000 averaged 507 students for the fall semester and 40 students for the spring semester. The enrollment for GE 1030 averaged 343 students for the spring semester and 91students for the fall semester. (Typically, all new freshmen take GE1000 in the fall semester and GE1030 in the spring semester while transfer students and students who failed the courses take the courses in the alternate semesters.)

The old course was designed to use four interdisciplinary modules throughout the semester. The hope was to keep the class size around 32. Each module was jointly developed by two or more faculty from two or more departments. The content of each module was to include a:

- PowerPoint lecture that gave an overview of the project and disciplines involved. This would take one day.
- hands-on "lab" activity for one day. The activity was to have a homework assignment associated with it.
- group (3-4 person) project.

The original intent was to complete the PowerPoint lecture and the hands-on activity for two modules in the first four weeks of the semester. Students would then choose the project they would complete for one of the modules, and work on the project in class for one week and out of class as needed. Each project required students to perform a more in-depth activity, write a report, and give an in-class group presentation. Following the in-class project work day, two weeks of class were devoted to presentations. This process then repeated itself in the second half of the semester.

While the intent of the course, described above, may seem reasonable, the implementation developed many problems:

- Although seven modules were produced, there was a wide disparity in the readiness of implementation of the modules. All modules had excellent project ideas, but some were lacking a complete presentation to be used to introduce the module. Others did not include homework assignments.
- No one faculty member, group of faculty members, or department had “ownership” of the course. While the course was taught in the General Engineering Department, most of the modules were created by professors in other departments. Additionally, the majority of the GE1030 sections were taught by faculty who had not developed any of the modules.
- No one oversaw the course to ensure that the delivery to the students was consistent.
- Faculty that taught the course organized the course in a way with which they were most comfortable. Some were following the original plan, while others were using six or seven short modules with more homework assignments and smaller or nonexistent group projects.
- Faculty that taught the course favored modules about which they were knowledgeable and avoided modules that were not in their areas of expertise. As a result, students had a wide variety of experiences depending on who taught the course they were taking.
- After a good start, most sections of the course grew to 40 students with some reaching 45. This made it more difficult to administer some of the hands on activities. It was also very challenging to have 45 students give more than one meaningful presentation.

Background – The New Course

The new course (implemented for the first time in the Fall 2009 semester) is intended to be a significant improvement based on several modifications. Its creation has been guided by best practices in the research, most notably the experience of Hoit and Ohland (1998). Hoit and Ohland developed a new freshman engineering course at the University of Florida that was

extremely successful in terms of retention and student attitudes. Their course, which was the inspiration for the revised GE1030 at University of Wisconsin-Platteville, was a laboratory-based course which gave students hands-on experiences.

Each section of the new course at University of Wisconsin-Platteville is team taught by seven faculty members, one from each engineering program. A faculty member from each of the seven engineering programs teaches a two-week module in which he or she introduces their program to the students through the use of a project that includes a hands-on laboratory component.

Each one of these discipline-specific modules is taught by a faculty member from the discipline's department who is knowledgeable and enthusiastic about the material. The modules include a hands-on component, and module developers were encouraged to ensure that the projects were meaningful, were not "busy work," and closely approximated what "real" engineering students worked on. Importantly, the developers had a vested interest in ensuring that the projects were challenging and meaningful, as a "dud" project would steer students away from the department. The modules are briefly described below.

- **Civil Engineering**: Students visit a site on campus between lectures, and in class they place a new academic building on that site, taking into account infrastructure needs and conducting a cost estimate.
- **Electrical Engineering**: Students explore the connections between time, frequency, and musical pitch with a single-chip variable-frequency synthesizer (a 555 timer), a variable-gain amplifier (a 741 op-amp), an oscilloscope, and a speaker.
- **Engineering Physics**: Students investigate metrology (the science of measurement). They measure the diameter of their own hair utilizing mechanical, electrical, optical, and even quantum mechanical means.
- **Environmental Engineering**: Students conduct a jar test and estimate coagulant needs for a fictional water utility.
- **Industrial Engineering**: Students explore how the use of industrial engineering tools makes both products and services more efficient and user friendly.
- **Mechanical Engineering**: Students dissect a small water pump, examine the construction of the pump, determine how it works, discuss why certain materials are used, and investigate the physics involved in pumping a fluid.
- **Software Engineering**: Students program in Alice, a software development tool that allows students to design and develop software in a rich, game-like 3-D animation environment.

In addition to the new content, the new course differs from the old course in that classes are smaller on average, and are capped at 30. Also, each class period meets for nearly twice as long (112 minutes) as compared to the old course, which allows time to conduct meaningful laboratory exercises. Additionally, the new course has some ownership, as each department developed, presents, and assesses their own module. Perhaps most importantly, each department has an incentive to do the best job they can do; presenting this module is viewed by many departments as an opportunity to deliver a "sales pitch" with which they can attract students.

The new course is supervised by the Chair of the General Engineering Department. He ensures that the grades for each module are turned in in a timely manner, and serves as the point of contact for students who otherwise would have seven different faculty members to sort through when problems arise. For the Spring 2010 semester, all sections had less than 30 students enrolled. This occurred because the Chair has been an advocate for sections containing no more than 30 students, and has strictly enforced this cap.

In summary, both the old and the new course are 1-credit hour courses, with the same prerequisite (College Algebra). For both courses, 14 sections are offered every Spring semester and 3 sections every Fall semester. In the old course (Spring semester), the number of faculty varied from semester to semester, but was typically taught by 6 – 8 faculty members. In the new course, seven faculty members teach the course, one from each engineering department.

Assessment

The research questions to be assessed is: does the new format of the course lead to a) improved retention; b) better understanding of various engineering disciplines by the students; and c) better-informed decisions by the students if they choose to change their major?

To date, assessment data is available for the Spring 2009 semester (last offering of the old course) and the Fall 2009 semester (first offering of the new course). Assessment of retention is not yet possible, but a preliminary assessment of the other two research questions has been undertaken.

The assessment results presented in this paper are from an end-of-semester survey. The survey was written by the authors of this paper and approved by the university's Institutional Review Board. Students signed an Informed Consent form prior to completing the survey. The end-of-semester survey was administered in the final exam period, in a ten-minute block of time before the final exam was handed out. Students were asked to place their names on the survey, but informed that they did not have to if they did not feel comfortable doing so. They were also informed that the surveys would not be looked at by anyone until after final grades were turned in, and that no one's answers would in any way affect their grade. Response rate was virtually 100% - every student that took the final exam also completed the survey. A total of eight questions were asked on this survey, but only the responses from three questions that address research questions 'b' and 'c' will be reported. A thorough analysis of other survey questions is currently ongoing.

Effect size was calculated using Cohen's d. According to accepted definitions, a Cohen's d value of 0.20 is considered "small" effect, 0.50 is medium, and 0.80 is large.

The first question to be addressed is a question that asked students to state their level of agreement with this statement: "I found this course to be worthwhile." Students were to respond to this question and all others using a Likert scale, with 1= Strongly Agree; 2 = Agree; 3 = Neutral; 4 = Disagree; and 5 = Strongly Disagree. The average score for the old course was 2.82

(n = 331) and improved to 2.29 (n = 70) for the new course. A 2-sample t-test resulted in a P-Value of 0.000 with a Cohen's d of 0.52. This finding is heartening, in that a positive impression of the course is expected to correlate with improved retention, better understanding of the engineering disciplines offered at the University of Wisconsin-Platteville, and better informed decisions about staying in (or leaving) a certain field of engineering.

The second question on the end-of-semester survey asked students to state their level of agreement with this statement: "In this course, I learned a lot about the different engineering disciplines at the University of Wisconsin-Platteville." The average score for the old course was 2.70 (n = 331) and improved to 1.91 (n = 70) for the new course. A 2-sample t-test resulted in a P-Value of 0.000; Cohen's d equaled 0.87. This result is expected to correlate positively with a student's ability to make well-informed decisions on their choice of major; further analysis of additional questions from the survey will determine if this correlation exists.

The third question on the end-of-semester survey to be reported here is a follow-up question to a short-answer question. (The short answer question asked those students who were planning on continuing in engineering to list their primary reason(s) for pursuing engineering.) The follow-up question asked students to state their level of agreement with this statement: "This class reinforced my decision to continue in engineering." The average score for the old course was 2.72 (n = 294) and improved to 2.15 (n = 60) for the new course. A 2-sample t-test resulted in a P-Value of 0.000; Cohen's d equaled 0.57.

The significant improvement in student responses begs the question: "is the new course easier?" That is, are students more favorable about the course because it is easier? Table 1 shows that the grades in the new course are much lower than the grades in the old course.

Table 1: Grade Distribution for New and Old Courses

	Fraction (as %) of students obtaining a grade of…				
	A	B	C	D	F
New Course	31.5	37.0	9.6	1.4	20.5
Old Course	51.1	33.8	9.3	3.5	2.4

Comparing n-values for the third question to the first two questions (294 vs. 331 for the old course and 60 vs. 70 for the new course) suggests a relatively high rate of retention (89% for the old course and 86% for the new course). However, any conclusions about retention must be based on actual future enrollment data rather than student intentions. Normally, about 55% of University of Wisconsin-Platteville students that begin in engineering obtain an engineering degree from the university.

Next Steps

These results are highly encouraging but are tempered by the fact that the new course was delivered to mostly transfer students while the old course was delivered to mostly second-

semester freshmen. The assessment will continue in the Spring 2010 semester offering of the course, which will be populated by mostly freshmen students.

Also, additional data awaits to be analyzed. A survey was also administered at the beginning of the course with nearly identical questions to the end-of-semester survey. These questions include responding via a Likert scale to these two questions: "I am certain I want to be an engineer" and "I am certain about my choice of engineering major." Moreover, students were asked to state the strength of their preference for each of the seven engineering disciplines that were covered in the course. Comparing students' start-of-semester responses to their end-of-semester responses will offer insight on the ability of the course to influence student attitudes and perceptions of the various disciplines.

The grade distribution in the Spring 2010 semester will be monitored. On one hand, the change in distribution of grades between the old and new course is encouraging as it should quiet the criticism from some faculty members that the course lacks rigor and is an "easy A." On the other hand, the low scores are a cause of concern, and if 1/5 of the students continue to fail, an investigation into the reasons for this high failure rate will be undertaken.

Cited Reference

Hoit, M. and M. Ohland (1998). The Impact of a Discipline-Based Introduction to Engineering Course on Improving Retention. Journal of Engineering Education **87**(1), p. 79-85.