A Consultancy model for a Freshmen Engineering course

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Abstract:

A freshmen engineering course became a consultant company working pro-bono for a real non-profit client. The goals of the course were to increase confidence in students, instill a service mind-set and give them a perspective of working with on real projects. The Civil, Architectural and Environmental students surveyed an existing building, completed a needs assessment, and created designs. Pre and post-tests show dramatic increases how students rated related measures.

Introduction:

Many researchers have focused on the causes of engineering student attrition and remedies to promote retention from year to year. Among the efforts have been using the Wright State model for engineering mathematics. Embry-Riddle is among the most recent universities to implement this, and they reported first year retention increased from 29% to 83%.[1] Although engineering math is not the focus of this paper, the author was involved in planning an offering of this at the subject University.

Another example of retention efforts is providing scholarships to transfer students.[2] This plus also creating a "one stop shop" which involved strengthening advisor relationships increased the expected graduation rate of transfer students to 100%.

North Carolina State University did a longitudinal study over several years of a new curricular plan.[3] Students were placed in a cohort of five introductory courses taught by the same instructor who used an active learning style. The 5-year graduation rate increased from 65% in the control group to 85% in the experimental group.

The University of California, Santa Cruz did a study where students were placed into study groups of pairs of students.[4] Students showed persistence in completing assignments and increased confidence in their solutions. The results benefitted all demographic groups studied but had the greatest benefit to female students.

It seems that there is little in common among the programs mentioned above. Many of the programs have a mix of factors. Some programs above target specific groups such as transfer students and use a mix of interventions that the authors feel will benefit that population. Perhaps, all of the endeavors focus on factors that contribute to a more common trait such as confidence. French states that motivation levels significantly related to persistence in a

program.[5] Their study evaluated several demographic factors and SAT scores, but found motivation was most important. However, the study didn't investigate how students became motivated.

Besterfield pointed out that motivation is especially important as students enter college.[6] This reinforces that programs to encourage retention should focus freshmen courses offered in the first term.

Dewitz tied confidence and sense of purpose together.[7] They found the importance of self-efficacy which is confidence in the ability to complete a task. They recommended interventions that directly influenced the students' sense of purpose. This would then create higher confidence levels.

Building self-efficacy was chosen by the author the focus of the freshmen engineering course discussed below. Each student could have their own difficulties, such transfer students being disconnected from resources, but by enhancing self-efficacy the students would be better able to seek their own solutions to obstacles to completing their studies.

The Course

The freshmen design course discussed was only for students in the engineering programs: Civil, Architectural or Environmental, or undecided. Related to retention, the main purpose for the course was to increase the students' confidence. However, this was not listed as a course outcome. The course goals as told to the students were:

- Behaving as consulting engineers and working with clients.
- Collecting field data.
- Applying engineering calculations to a real world problem.
- Identify themselves as a helpful person.

The students would work with a non-profit client organization and they would do the same things that real engineers have done. Then the students would see the impact of their work. This would build their confidence.

In addition, since this was a service learning course, there was an additional goal of Community Engagement. This course was an atypical service learning course because all of the students and faculty member went to the client site together. Also, rather than "scooping soup", the students applied engineering skills to helping the non-profit client. This style of service learning more deeply engaged the community than some service learning courses because the full curriculum of the course was engaged with the student service projects.

Student projects were all related to issues with infrastructure such as buildings or properties. Architectural engineering students commonly chose projects related to energy use or quality of lighting. Civil Engineering students sometimes worked on issues of drainage of properties, such

as complying with new local codes for detention of rain water. Environmental engineers found air quality issues needing attention. It was important that the students show flexibility because the greatest client needs didn't always match with students' primary area of interest.

This sort of course is very intensive for the faculty member teaching it. In the six years the course has been offered with this curriculum, it typically takes several weeks of summer to develop relations with a potential client, and vet the project site to be sure there are sufficient relevant projects for the students to work on. Then, anticipating the types of projects that will be encountered, customize the lectures to those needs. Finally, following the course, the faculty member needs to follow up with the client to see what help they need for completing long-term projects.

The first day of class begins with the faculty member "hiring" the students as interns in a pro-bono consulting firm. Students realize that they are doing this for coursework and are not being paid.

As soon as possible, the students meet representative(s) of the client organization and get an overview of problems at the client's site. Upon return to class, immediately the students think about which are the biggest concerns and creative solutions to those problems. This helps them find a connection between the client's needs and their interests.

The curriculum is variable each year and for each student. Since each project is different, the required reading assignments vary for each student. Students are required to hand in marked up reading notes from the course web page. Lectures deal with general concepts or a few specific design methods that are common to several projects.

Next, the class returns to the client site for data collection. Following this the students begin their design process. This is the most intensive time of faculty work since each student will be working on a separate project and they will all have questions and need guidance.

A proposal presentation to the client representative(s) is done around the tenth week. Each student will have their own proposal, but to keep the presentations short, not every student presents at this time. Students are only required to present once in the semester such as at the final exam. The team leader or area leader typically presents the proposal to the client. See sample work in Figure 1.

Figure 1. Student CAD drawing of roof areas contributing to drainage catchment Modified downspout

Then near the last week of the course, the class visits to help implement some of the projects. Some of the projects are small and can be implemented immediately such as changing lighting. This is time is close to typical service learning. See sample service result in Figure 1. However, some projects take much longer such as large construction projects. In the time between presenting the proposals and doing the service on-site, the faculty member works with the client to help them decide which projects they can implement with the class's help and to get prepared for the day. At the same time, students are working on final reports and focusing more on technical graphics and CAD drawings.

Results:

Students were given a pre-test and post-test where they self-assessed their abilities. The prompts were:

1. I am ready to help clients as an engineer.
2. I can collect data on a job site.
3. I can apply engineering calculations to real problems.
4. I am a helpful person.

The students were asked to rate themselves on a 5 point Likert scale as to how much they agreed with the statements above. For example, a student saying they "strongly agreed" would select "5". The options were:

1. Strongly disagree
2. Disagree
3. Neutral
4. Agree
5. Strongly agree

See Figures 2 to 9 below for the results of the pre and post-tests. All questions showed significant increases in student self-assessment. Mean responses increased by 0.45 to 1.89

levels. The greatest increase in response was for question 1-working with clients. The lowest increase in response was for question 4, but students rated them veray highly to begin with, so there was little room for improvement. The t-test for independence were 79%, 99%, 99%, 99% for questions 1 to 4, respectively.

Other factors could have impacted the students' increase in performance. First, this wasn't the only engineering course they were in. Most students were also in an Engineering Math course that follows the Wright State model. However, the only question that could be affected from that is the third one which concerns engineering calculations. Second, the purpose of education is development. Being a University student can affect how students relate to others and this could bias the first and last questions.

Retention has also been high. The average retention from freshmen to sophomore year for these students is more than 80% which is higher than for other groups of students.

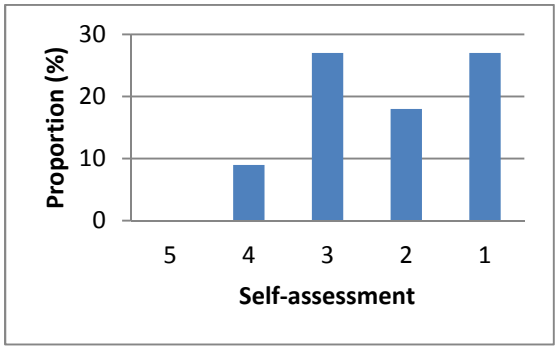

Figure 2. Working with Clients, Pre-test

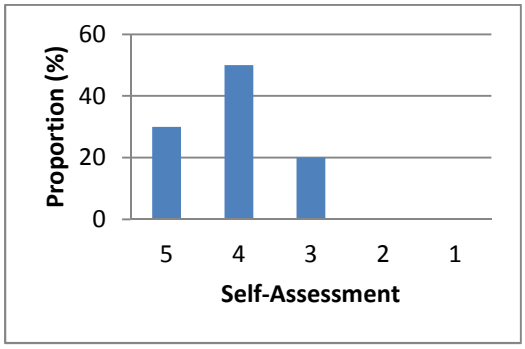

Figure 3. Working with Clients, Post-test

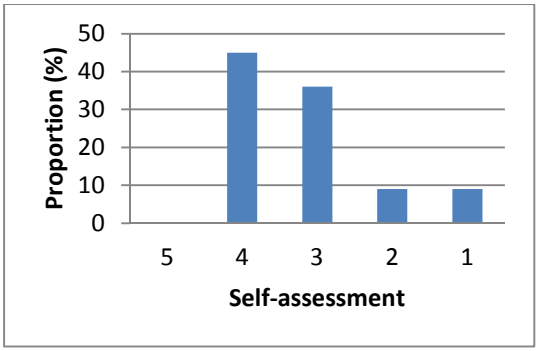

Figure 4. Collecting Data, Pre-test

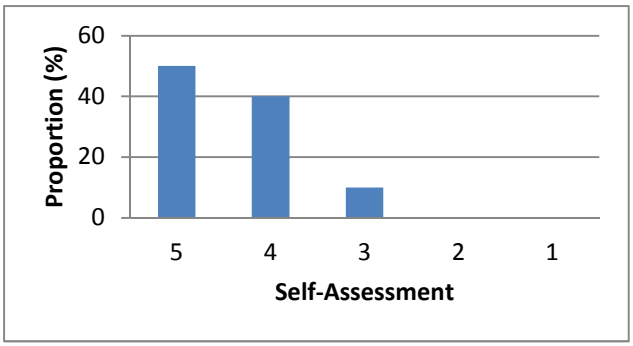

Figure 5. Collecting Data, Post-test

Figure 6. Engineering Calculations, Pre-test

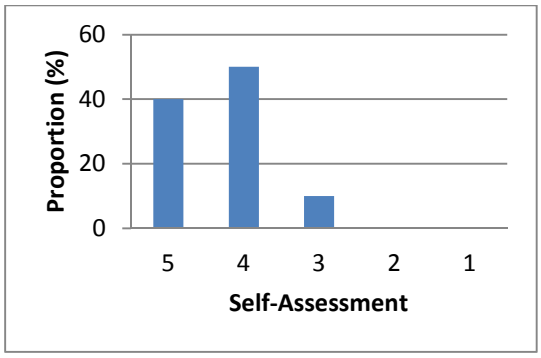

Figure 7. Engineering Calculations, Post-test

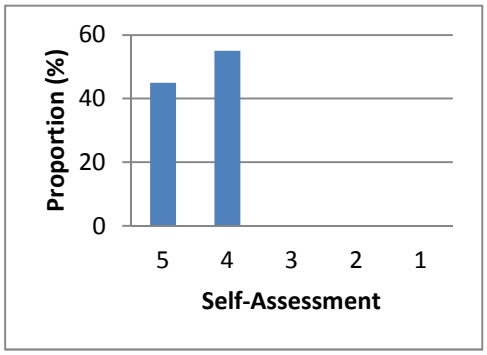

Figure 8. Helpfulness, Pre-test

Figure 9. Helpfulness, Post-test

There was no space for comments on the post-test. However, during discussion, the students said that they most liked working with a client. They least liked how the problem was ill-defined and they had to work to define it to have something to solve.

Summary

Students claimed that they enjoyed the course. They most appreciated working with real people.

The students' confidence significantly increased as seen in several metrics. This may have been a factor in their higher retention rates. More recent efforts such as implementing the Wright State model for engineering math will also affect the students.

This type of course is extremely challenging for the faculty member offering it. The commitment of time is well above those of other lecture courses. The broad curriculum requires the faculty member to be technically proficient in many areas. Also, dealing with students who are all working on separate things is hectic for the faculty member.

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