Engineering 098 Pilot Focus Groups – Results and Analysis

OVERVIEW

The purpose of this study was to determine the extent to which the course outcomes in the pilot offering of Introduction to Engineering Design (ENG 098) had been met. Students from the pilot offering were interviewed in groups about the content knowledge they gained and their experiences in the course as well as the College of Engineering (CoE) in general. The research design was informed by CoE administrators' interest in engaging "students in engineering design while improving their oral communication skills,"[1] while also creating conditions that can improve retention.[2]

METHOD

Participants

Twenty-five first-year engineering students (12 male, 13 female) enrolled in Introduction to Engineering Design (ENG 098) during the Fall 2014 quarter. All were participants in the Special Transitional Enrichment Program (STEP). A purposeful sampling procedure was used and a member of the undergraduate Student Assessment Research (StAR) team used the class roster to distribute students into four groups trying to ensure that each group contained students who had not worked together on a project in the class. An invitation to participate in the focus groups was sent by email from the CoE Undergraduate Education Office (Appendix A) to each of the enrolled students. Twelve students (8 female, 4 male) participated in four focus groups, held during one week in the Spring 2015 quarter. The participants were enrolled in the following engineering majors: Materials Science, Mechanical (3), Civil (5), Biological Systems, Computer, and Chemical.

Research Design

Focus groups, or group interviews, are a commonly-used qualitative data generation strategy in which a facilitator leads a discussion with groups of participants. As in one-on-one interviews, questions for focus groups range from highly-structured to not-structured, depending on the overall purpose of the research. In either case, the "purpose of qualitative interviewing in social science research today, as of qualitative research in general, is to understand the meanings of the topic" (Warren, 2004, p. 521). Interviews allow a researcher to get an in-depth look at

1 Excerpted from the Report from the Engineering Communications and Design Committee.

2 *ibid,* "Many students leave engineering because their freshmen level courses include little engineering content or connection to the creativity involved in open-ended problem solving. A freshmen level course that includes an introduction to design would expose students to the application of math and science to real world problems and instill an appreciation of the problem solving skills needed for engineering."

participants' knowledge of, attitudes about, and suggestions for programs in which they have participated. Particularly useful in program evaluation, data from focus groups can provide insight as to whether a program has achieved its desired objectives.

Data Collection

The semi-structured interviews were scheduled for 90 minutes each. In addition to audio recording the interview, the members of the Student Assessment Research (StAR) team took detailed notes on laptop computers, and wrote research memos after the interviews. Professional transcription of the four interviews resulted in 326 double-spaced pages.

Data Analysis

For the initial analysis, the research team used a deductive coding process, which is used to test a hypothesis or theory by applying *a priori* categories to the data. In this case, the coding categories reflected the four course learning outcomes:

- Communicate effectively the process for design
- Work and communicate in teams
- Develop design concepts for customer needs; and
- Present ideas professionally.

One student researcher and one staff researcher read the transcripts multiple times each to identify how often participants talked about, and/or provided evidence of mastery of, the course outcomes. Subsequent readings allowed the researchers to refine the categories to reflect some of the more specific course goals as outlined in the course proposal, as well as identify other themes in the data. The research team met regularly to discuss the coding process and refine the analytic categories. The final coding categories were:

- Communication – subcategories included confidence, practice/presentation, strategies, opportunities to practice outside of the course, listening, application of constructive feedback, awareness of knowledge limitations, and ability to communicate the design process.

- Teamwork – subcategories included listening, scheduling, conflict resolution, responsibility/delegation, dynamics, deadline, initiating teams in other classes, and communication.

- Design – subcategories included constraints, research, process, creation, build prototype, test, and redesign.

- Retention – subcategories included environment, positive advising interaction, community, optimism, enthusiasm, high school exposure to engineering, attitudes towards the course, and connection to career and personal goals

RESULTS

Analysis of the transcripts revealed the overwhelming perception that, according to the students who participated in the focus groups, the pilot successfully provided ample opportunities to practice toward mastery of the course learning outcomes. The analyses also revealed examples of proxies for retention. (see Table 1 in Appendix B).

Communication

Participants provided many examples of how their confidence and competence with professional communication improved as a result of the course. They consistently described the strategies they learned, and their comments provided insight into other aspects of communication that they practiced. Many students spoke about how they used strategies observed in their teammates and/or classmates to improve their own presentations. The participants also spoke very positively about the feedback they received from their peers and the T.A. and how they incorporated it into their final projects. Many participants cited examples of times they used techniques learned in ENG 098 in other classes or in interactions with faculty. The incorporation of observed strategies into participants' work and the assimilation of individuals' ideas into a group project was considered evidence of listening and grouped with communication. In addition, a few students spoke positively about discovering the limits of their knowledge and the process of learning to accept those limits with the understanding that it will come with subsequent coursework. The quotes below represent the ways participants talked about and demonstrated their understanding of the principles of communication they learned during the course. [3]

> Gabriel:[4] "Like, they were talking about, like, oh, how would an engineer, or how to write, like, a proper email, right? Which I used to actually contact the professor and ask for a letter of recommendation, which was a cool thing."
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> Angela on her communication skills: "Definitely better than before I was taking the course."
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> Olivia on how useful feedback was on group projects: "Really useful. Because we had things to improve on, and then the things that were good, we would have kept doing it."
>
> Vanessa, who had had previous instruction in communication: "It – yeah. Just because it was a really good reminder. At first, I was like, oh, this is so unnecessary. I don't even need to know this. But then, a little bit down the road, I was presenting in class and I was like, oh, I'm using all the things I learned from Engineering 98 in this class. I might not have known it, but I was, and so that – I – I liked that."
>
> Angela: "You have to be clear with your presentations and you have to take into consideration who your audience is and their interests."

[3] Student quotes were edited to remove discourse markers (e.g., "like" and "uh"), which might distract readers from the content.

[4] All names are pseudonyms.

Kathryn: "I was able to present myself better and I felt more confident in myself…"

Luis: "…the practice with communicating and presenting actually not only helps with engineering, but I felt it also helped me in my other courses."

Teamwork

Overall, the participants had positive things to say about working and communicating with teams. In addition to learning how to negotiate with their individual teammates, they provided examples of how they worked with their classmates, and described what they learned from the process. A few participants demonstrated valuing teamwork as integral to the engineering discipline and discussed how they thought they might initiate groups or teams in future courses.

Carlos: "For our – for our team, it was kind of, like, each person was designed – assigned a certain task so, even if they weren't able to meet at that time, they were still responsible for completing their task."

Haley: "I think what I took from this was – the professor was talking about how, nowadays, people who work in engineering don't ever – like, it's so rare that they work alone. And so working in a team is a must. And you need to be cooperative with everyone else."

Vanessa: "Everybody was interested in one thing or the other, and we all just came together. It wasn't – it was weird, because usually I'm used to having one person take lead, and nobody took lead. Everybody was a leader."

Jasmine: "When you work together, what you don't understand probably another does and understands it, so you can come up with a different solution. So, I think it's like using two brains for one."

Design

Learning about the design process resonated strongly with most participants. In particular, the students talked about the criteria they now know they need to consider to be successful at design: attributes, features, and constraints. Many of the students described, with enthusiasm, the joy of designing their own projects. They appreciated the opportunity for hands-on, real-world application at such an early stage in their academic career. The participants' ability to articulate the design process was evident, as was an ability to leverage their learning in future courses and to meet career goals.

Isaac: "And now, when you think – when I think about creating something, you know, like, creating my ideas, making something out of nothing, I think about those three things: constraints, features, and attributes."

Jasmine: "It was interesting, too, we also felt we were somehow professionals as a freshman. I guess it's the first time ever that we get to experience something that seniors are barely experiencing…"

> Marissa: "So, I think they gave us a preview of how it will be when we're actually reaching that point when we're working already and using what we know."

Retention

Research shows that college student retention and persistence is influenced by both academic and non-academic factors. Tinto's Theory of Student Departure (1975) states that student persistence depends on a student's ability to successfully integrate into the institution both socially and academically. Current theory explores the role of the institution in student persistence and retention and suggests that universities and students share the responsibility of academic and social integration (as cited in Jensen, 2011). Specific factors influencing student retention are shown in Table 1 (Appendix B). During the interviews, many of these factors were mentioned and overall, students' perceptions of the discipline, the College, UC Davis, activities available, community, and relationships with advisers and faculty were positive.

> Vanessa, on choosing UC Davis: "And so, I just fell in love with the campus and the people here and that's why I chose Davis – because I really just loved how happy everybody was and how – I don't know – they were just so welcoming on my tour, compared to when I toured UCLA."
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> Luis, on experiences with advising: "And so, Tanya, my advisor, that's kind of like – I don't know, she kind of just pulls me through sometimes. I wasn't having the best weekend this weekend that just passed and I just talked to her, like right now, at one, so I just had my meeting with her. And so, just getting boosts from, just people that have known students that are struggling with the same things. I don't know. I feel like they – that's beneficial.
>
> Carlos, when asked how student's can keep themselves from getting frustrated when their other classes aren't as hands on: "Well, I feel like there's opportunities to do that. Like, for example, there's the Steel Bridge project, or the Concrete Canoe, so, I mean, it's kind of based on what you want to do. So, if you want to get that hands-on experience, you can get yourself involved and stuff like that."

DISCUSSION

Determining the effectiveness of *any* pilot project requires longitudinal data and multiple lines[5] of evidence. Given the developmental nature of learning, it is impossible to know with any certainty that what the pilot students learned will "stick." As the analyses above demonstrate, however, the focus group participants provided ample evidence of their mastery of the course outcomes. Participants were not only able to articulate the course goals, but demonstrated ability to communicate about the design process and the value of teamwork; they also reported overall satisfaction with the course. The participants were especially enthusiastic about the hands-on

[5] The focus group data represent an important, but understandably limited, line of evidence.

opportunities provided by this course and were anxious to experience more of those opportunities in courses to come.

Similarly, an evaluation of the impact of the Engineering 098 pilot on retention within the College will necessarily be a complex and long-term undertaking. In the meantime, however, we can look for proxies for retention, such as feelings of connectedness to a program or college, opportunities for research, faculty and staff support, etc. Participants described their connections to the College, some of which started during pre-decision visits; they recognized the myriad extra-curricular opportunities through which they can continue to gain engineering experience. Perhaps most importantly, the participants were able to articulate the connection between Engineering 098 and their future coursework and careers.

Two caveats with regard to the presence of factors that positively influence retention: all of the students in this pilot were involved in STEP, and some in LEADR, so the feelings of connection and community, and positive advising interaction may not be as prevalent in students who have not participated in STEP. Secondly, seven of the twelve students interviewed had been exposed to engineering in high school, either through specialized STEM programs or experience in Physics (and in one case, English) courses. This previous exposure could also influence the enthusiasm for the discipline, and confidence in academic ability in science, which may be less frequent in students without exposure to engineering in high school.

Effective course design

The study confirms that the pilot created opportunities for students to develop the skills described by the course outcomes, as stated in the syllabus. When prompted, participants provided suggestions for future iterations of the course. Please note that even while they were making the recommendations below, most participants appeared to understand why some of their ideas aren't practical. For example, almost all of the students said they wished they could have brought the design process to fruition by building prototypes. Clearly, the expense of building a large-scale egg washer presents a serious constraint to the feasibility of this idea. An example of a suggestion that might be more easily implemented is to increase opportunities for hands-on practice through additional "mini-studios." A related suggestion was for each "mini-studio" to feature different engineering disciplines.[6]

Next Steps:

As a follow-up to this study, consideration should be given to exploring the natural control group of students who did not take ENG 098. There are two populations to evaluate: 1) STEP students who did not take ENG 098, and 2) non-STEP students who did not take ENG 098. Group 1 would serve as a control to this population, and group 2 could provide insight into retention factors between STEP and non-STEP participants.

[6] This approach might be a practical demonstration of how engineers approach and solve problems from different disciplinary perspectives.

APPENDIX A – RECRUITMENT EMAIL

From: Engineering Undergraduate Office
Sent: Tuesday, March 03, 2015 2:16 PM
To: [participant name]
Cc: T Whitlow; Kara Moloney
Subject: College of Engineering Focus Group - Introduction to Engineering Design

Dear [participant name],

The College of Engineering needs your insight and expertise!

We are evaluating the effectiveness of the pilot course Introduction to Engineering Design (ENG 098), and want to hear from the students who took the course in Fall 2014. In order to capture the breadth of your experience in a confidential setting, we have asked the staff and students from the Undergraduate Education Assessment Team to conduct group interviews (sometimes called focus groups). They will record the interviews (audio, video, and notes), analyze the data, and then will report their aggregate findings to the College. Your privacy and identity will be protected to the fullest extent possible: participants will be assigned pseudonyms, and identifying information will not be included in the reports.

You have been assigned to the group interview on [Date, location].

If you have a conflict with the time / day, please contact the Student Assessment Research Team coordinator Stephayne Gascón (sngascon@ucdavis.edu).

If you have questions about the group interviews, please contact the Undergraduate Education Assessment Team coordinator Kara Moloney (kmoloney@ucdavis.edu).

We sincerely thank you for your participation.

Best,

Jean Vandergheynst, Associate Dean • Research and Graduate Studies
J-P Delplanque, Associate Dean • Undergraduate Studies, and
Jim Schaaf, Assistant Dean • Undergraduate Programs and Advising

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APPENDIX B FACTORS INFLUENCING RETENTION

Table 1. Factors and Contributing Measures Influencing Retention

Factors Influencing Retention	**Examples**
Individual Level	
Academic Performance	College GPA and academic performance, high school GPA, course load and credits earned, academic self-discipline
Attitudes and Satisfaction	Positive attitude about academics, commitment to college, sense of belonging and social connectedness
Institutional Level	
Academic Engagement	Undergraduate research activities, university size, opportunities to join clubs
Social and External Level	
Social and Family Support	Faculty and staff support, family support, familiar and authentic cultural environment, sense of belonging and community, mattering or sense of importance

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