A Course to Promote Informed Selection of an Engineering Major using a Partially Flipped Classroom Model

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Abstract

A 1 credit hour First-Year Engineering Course which provides background to students on the engineering disciplinary options available to them was redesigned to help inform the selection of their engineering major for future study. Initially, course administration was a large lecture class but was transformed into a smaller classes that were partially flipped (for the first half of the semester, the content was presented in videos posted on-line relating to engineering disciplines) that allowed students to attend sessions that were of greatest interest to them. Both versions of the course were assessed through surveys. Finally, all students enrolled in the redesigned course were interviewed to discuss their progress in selecting an engineering major. The baseline data from the original course and data from the redesigned course were compared to better understand the effectiveness of the approach for informed selection of an engineering major. And while there were no statistically significant difference between the original course and the redesigned course in terms of background knowledge gained; the newly designed, partially-flipped course was more effective in all other categories. Statically significant improvements were found for students in terms of: learning, interest, and engagement. In the case of engineering major selection, a partially flipped classroom is deemed an effective approach.

Key Words: *Partially Flipped Classroom, Major Selection, Engineering Education*

Literature Search

Motivation

Engineering educators are tasked with changing traditional ways of educating engineers and broadening the exposure of students to engineering careers, requirements, and opportunities (NAE, 2005). With the wide range of research citing the need to transform traditional lecture courses into more interactive and responsive environments (Bonwell & Eison, 1994; Felder & Brent, 2009; Goodman, Cunningham, Lachapelle, Thompson, Brennan, Delci, 2002; Prince, 2004), many colleges and universities have begun transforming their engineering curricula in favor of active learning approaches. One such approach is the "flipped classroom," which Bishop and Verleger define as: "an educational technique that consists of two parts: interactive group learning activities inside the classroom, and direct computer-based individual instruction outside the classroom" (2013). Recently, the flipped classroom approach has increased in popularity although the studies published recognizes both challenges and benefits to the method (Mason, Shuman, & Cook, 2013; Strayer, 2012). Theoretically, this pedagogical approach is based on Bloom's taxonomy. Typically the lower-level of the revised Bloom's taxonomy skills of remembering and understanding (Anderson, 2001) are completed prior to class without faculty guidance, while the higher level Bloom's taxonomy skills are the focus of class work when faculty guidance is available. In the current study, it was hypothesized that a partially flipped classroom model could benefit students in the selection of an engineering major. Specially, by offering on-line videos that describe the major as outside of class work (lower-level) and utilizing class time for interactive activities that give students a true sense of what a professional would do in that given field of study (higher-level).

Flipped Classroom Model

Some of the reported benefits of the flipped classroom model include: making effective use of class time, making good use of technology, accommodating various learning styles (Mason, Shuman, & Cook, 2013; Bland, 2006), helping students become self-directed learners (Mason, Shuman, & Cook, 2013), promoting life-long learning skills (Bland, 2006), fostering collaborative learning (Bland, 2006) and personalized learning (Redekopp & Ragusa, 2013), and increasing classroom engagement (Redekopp & Ragusa, 2013). Investigating one specific benefit, Stickel et al. surveyed students and found that the level of faculty student interaction increased with the inverted classroom model compared to a traditional classroom (2014). It has also been reported that students enjoy the direct interaction of faculty during class time and the flexibility to learn new course material on their own (Velegol, Zappe, & Mahoney, 2015).

While it was hoped that the students would see the benefits of the inverted classroom approach, students were less positive about the flipped classroom technique after they had experienced it than they were before. There are several potential reasons as indicated by prior studies, including the natural tendency to resist change -- students may be reluctant to try a new method (Mason, Human, & Cook, 2013; Herreid & Schiller, 2012) especially since it requires a change to the way that they have approached course work and course preparations. Additionally, it has been reported that linking the videos to in-class exercises is critical to successful implementation so both elements positively support each other and do not appear to be independent (Herreid & Schiller). Further, there is not a "one size fits all" model for a flipped classroom (Swartz, Velegol, and Laman, 2013), the content and the instructor's approach are critical to the types of situations best suited for a flipped classroom. In fact, there may be portions of a course that are more appropriate than others to employ the flipped classroom model and selecting the most suitable times is critical to successful implementation (Kecskemety, Bucks, & Meyers, 2015). There have also been documented institutional factors that influence implementation and student reaction to the flipped classroom (Kecskemety, Bucks, & Meyers, 2015).

Major Selection

The selection of an engineering major has been called "the uninformed choice" (Seymour and Hewitt, 1999) yet it is a critical decision that has long term implications both professionally and personally. A prior study by Arcidiacono related to major selection found the decision to be related to student ability. He also noted the vast long term monetary implications for such a decision, which was driven primarily by student interest in a studying a particular major during college and secondarily to a student's preference for professional work. In general terms it has been documented that students who earn a degree in natural science earn significantly more than students who major in the humanities and social sciences; however, more recent work is focused on understanding how student ability and performance effect major selection. Finally, high ability students (which is linked to math achievement) have been found to shift to majors that result in more profitable professional pathways and lower ability students shift to "easier majors" (Arcidiacono, 2004). Student expectation of future earnings coupled with ability have been found to be critical determinites of college major; however, these perceptions may have errors that would influence major change (Arcidiacono, Hotz, & Kang, 2010). Social Cognitive Career Theory is based on the idea that career development is a process related to self-exploration and choice although there can be barriers to career pathways: "a complex array of factors such as culture, gender, genetic endowment, sociostructural considerations, and disability or health status operate in tandem with people's cognitions, affecting the nature and range of their career possibilities" (Lent, Brown, & Hackett, 2002). This exploration and selection of an engineering major is often a focal point of First-Year Engineering Programs, and this experience has been found to be "polarizing" either affirming a student's plans to study engineering or a specific discipline or dissuading them all together (Meyers, Bucks, Harper, & Goodrich, 2015). Theoretically focused on Social Cognitive Career Theory, an engineering course designed to help students make an informed selection of an engineering major was assessed.

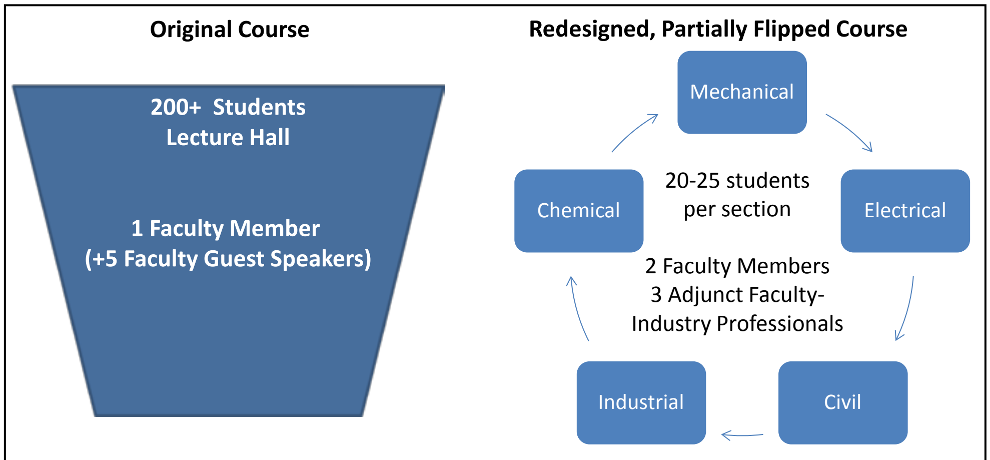

Figure 1. Comparison of Course Structures

Introduction

A 1 credit hour course that is required for all incoming First-Year Engineering students was assessed before and after a course redesign. The goal of the course was to provide background to students on the engineering disciplinary options available to them; intended to make student selection of an engineering major "an informed choice." The institution studied is a medium sized university with an undergraduate population of approximately 13,000. Each year the First-Year Engineering Program enrolls 200-250 new students, with ~1,000 students in all engineering program across disciplines.

For many years, the approach to teaching students about the different engineering disciplines available at an Urban, Public University was a large enrollment, lecture format course. It was a passive learning environment that was administratively simple with a single section and one faculty instructor. The course is not atypical of an institution with a common First-Year Engineering Program in which students take common courses the first year and then select an engineering major at the end of that year. The course design did not consider more recently developed educational best practices and was unpopular with students as indicated in the baseline data collected. To address student concerns and promote informed decision making, a proposal for an educational innovation related to redesigning the course was submitted and accepted by the National Academy of Engineering Frontiers of Engineering Education Symposium in 2013. Working with other educators from across the country a new approach to teaching First-Year engineering students about the different engineering disciplines was developed and implemented in the fall of 2014.

The primary goal of the course remained constant throughout the redesign: to help educate students on the five different engineering disciplines (Civil, Chemical, Electrical, Industrial, and Mechanical) offered at the institution in support of informed major selection. The objective was to expose the students to each of those majors so that they initially select the best engineering major for themselves to promote educational and professional persistence (as well as to minimize major changes and time to graduation). The original course involved 1 large section of 200+ students with 1 course instructor, and each of the five engineering disciplines had 2 weeks to present information on their program. There were 2 weeks left at the end of the semester in which students also heard about internship and co-op opportunities available to them as well as a panel of professionals from different engineering disciplines.

The newly designed course involved using 5 instructors representing each of the disciplines of engineering (2 full time faculty and 3 industry professionals hired as adjunct faculty) over 10 sections of 20-25 students per section to engage in small group activities. Students attend a session for each discipline on a weekly rotating basis. Figure 1, above, is a graphical representation comparing the course structure of the original course (left) and the newly designed course (right).

The new course cut the time spent on the five disciplines in half such that each discipline had only 1 class session but the time was used to work on a hands-on activity related to that engineering discipline. In preparation for class each week, students were required to watch a short (5-10 minute) video on the engineering discipline they were focused on in class that week (flipped class-

Week #	Original Course (2013)	Redesigned Course (2014)
1	Introductory Class Session	
2	Lecture on different engineering disciplines: Each of 5 disciplines (Civil, Chemical, Electrical, Industrial, and Mechanical) have 2 - 50 minute class periods	Hands-on Class Sessions on each of the 5 engineering disciplines (Civil, Chemical, Electrical, Industrial, and Mechanical) 1 - 50 minute class period
3		
4		
5		
6		
7		Resume Workshop and Co-op / Internship Discussion
8		Choose Which Discipline: Faculty representatives (academic requirements of a discipline)
9		Choose Which Discipline: Upper Division Students
10		Choose Which Local Engineering Company to Tour
11		Choose Which Discipline: Engineering Campus Lab Tours
12	Lecture on Co-Op / Internship Opportunities	Choose Which Discipline: Professional Society Panel of Student Members
13	Panel of Engineering Professionals from different disciplines	Choose an engineering professional to conduct an informational interview
14	N/A	Final Exam: Meet with an Engineering Course Instructor to Discuss Engineering Discipline Selection

Table 1. Week by Week Comparison between the Original and Newly Designed Courses

room). The students also participated in a resume workshop with professional practice staff leading sessions in a computer lab. Then the remainder of the semester was devoted to student choice, where students could select which class they wanted to attend depending on their engineering disciplinary interest (five sessions were going on in parallel in different rooms, students would go to the room of the session they wished to attend). These sessions were mostly lecture format; however, the class sizes were small to allow interactive discussion. Some of the disciplinary class sessions included meeting with engineering faculty, upper division students, off campus tour of an engineering facility, interviewing an engineering professional. On a weekly basis students were required to complete a survey and journal entry of their reaction to the prior week's session. There was also a "final exam" for the course which involved every student meeting with one of the five course instructors to discuss their selection of an engineering discipline for futures study (15 minute meeting). A week by week comparison of the original course to the redesigned course is shown in Table 1 on the previous page. The grey cells indicate the class sessions that are based on student choice.

This paper seeks to expand the engineering educational communities understanding of how a "partially flipped classroom" can aid in the informed selection of an engineering major, and addresses the following research questions which compares the original (2013) to the newly designed (2014) course:

1) *Through which course structure did students gain a higher level of background knowledge of the different engineering disciplines?*
2) *Which course structure was more effective for student learning?*
3) *Which course structure yielded higher student interest?*
4) *Which course structure had a higher level of:*
   a. Student engagement?
   b. Distraction?
5) *Through which course structure did students indicate a higher degree of certainty of their engineering discipline selection?*

Methods:

Students participated in multiple surveys during both the baseline course administration in 2013-2014 as well as the newly designed course in 2014-2015. Students were asked to report which engineering discipline they were most interested in pursuing (and how certain they were of that discipline selection) at 3 points: (1) at the start of the semester (prior to learning about any of the engineering disciplines in class), (2) at the middle of the semester, and (3) at the end of the semester. At the end of the fall semester when students completed the engineering orientation course students were asked about their perceptions of the course and their responses were analyzed statistically. Responses were collected using BlackBoard, and while responses were not anonymous, all identifying information was removed from the dataset prior to analysis and replaced with a generic "respondent identification number." Table 2, above, is a summary of student survey respondents from each administration.

Course Administration	Potential Respondents	Total Respondents	Response Rate	Male Respondents	% Male Respondents	Female Respondents	% Female Respondents
2013-2014 Original Course	234	204	87.2%	167	81.9%	37	18.1%
2014-2015 Newly Designed Course	207	192	92.8%	145	75.5%	47	24.5%

Table 2. Summary of Student Survey Respondents

Survey Questions	2013 Mean Student Responses			
5 Point Likert Scale (higher values indicate a more positive response/ greater agreement)	**All Students (204)**	**Male (167)**	**Female (37)**	**P Value: Rank Sum Male vs. Female**
To what extent did your background knowledge of the 5 engineering disciplines at YSU increase by taking this course (ENGR 1500 only)?	3.87	3.89	3.76	0.35
To what extent do you feel that the actual time spent in class for ENGR 1500 was interesting?	3.64	3.72	3.27	**0.02***
To what extent do you feel that the actual time spent in class for ENGR 1500 was engaging?	3.23	3.32	2.81	**0.02***
To what extent do you feel that the actual time spent in class for ENGR 1500 was effective for student learning?	3.80	3.89	3.40	**0.003****
How often did you find yourself distracted during class for ENGR 1500? (i.e. wanting to check your phone, etc)	3.07	3.00	3.37	**0.046***

* denotes $p<0.05$, ** denotes $p<0.01$

Table 3. Summary of Responses from Original Course (2013)

Summary statistics are reported, as well as Wilcoxon Rank-Sum Tests of statistical significance were evaluated. Rank-Sum tests are a non-parametric test that does not assume a normal population distribution. All of the questions were on a Likert scale, and the quantitative responses were coded such that a more positive response was a higher value and a less positive response was a lower value. Statistical analysis was conducted using the statistical software package STATA®.

Data was again collected based on student reaction to the course as well as the retention and rate of disciplinary change were tracked. All students enrolled in the course were invited to meet individually with a faculty member at the end of the newly designed course to qualitatively understand their perspective on the selection of a major, 89.5% of students were interviewed.

Results:

Original Course 2013-2014:

Students were surveyed about their perceptions of the course and the responses were compared for differences between (1) Honor Students, (2) white and non-white students (effectively grouping all minority groups to compare against the majority group) and (3) female and male students. The honor students met in a small class of ~35 students but sat through the same lecture format that all the other students did in a large lecture (200+) class setting. There were no statistically significant differences between the honor students and all the other students indicating, that just reducing the class size but not the approach (active vs. passive learning) did not improve the student experience. And while there were no statistically significant differences for minority students there were for women. In fact, women rated the course lower in terms of how it influenced their selection of engineering major as well as how interesting, engaging, and effective they found it. Finally, women students also found themselves more distracted during class. So while all students gave feedback that the course was ineffective, it was particularly ineffective for women. As shown in Table 3, above, women consistently indicated lower ratings as to the use of class time and their engagement.

Redesigned Course 2014-2015:

The course was redesigned as described previously to shift from a lecture format, smaller class size involving active learning, and student choice over session selections. Following the same procedure as the baseline study of the original course, students were surveyed multiple times throughout the First-Year Engineering Courses. The survey at the conclusion of the redesigned course asked students to indicate their perceptions. The results were quite different than the original course; however, male and female students that participated in the newly designed course reported similar perceptions. The only statistically significant difference was in terms of how effective students rated class time which was now actually rated higher

Survey Questions	2014 Mean Student Responses			
5 Point Likert Scale (higher values indicate a more positive response/ greater agreement)	All Students (192)	Male (145)	Female (47)	Z Value: Rank Sum Male vs. Female
To what extent did your background knowledge of the 5 engineering disciplines at YSU increase by taking this course (ENGR 1500 only)?	3.99	3.94	4.12	-1.433
To what extent do you feel that the actual time spent in class for ENGR 1500 was interesting?	4.20	4.19	4.26	-0.527
To what extent do you feel that the actual time spent in class for ENGR 1500 was engaging?	4.11	4.06	4.29	-1.901
To what extent do you feel that the actual time spent in class for ENGR 1500 was effective for student learning?	3.94	3.87	4.19	**-2.193***
How often did you find yourself distracted during class for ENGR 1500? (i.e. wanting to check your phone, studying, etc.)	3.85	3.82	3.96	-0.587
* denotes p<0.05				

Table 4. Summary of Responses from Redesigned Course (2014)

Survey Questions	Original 2013 vs. Redesigned 2014		
5 Point Likert Scale (higher values indicate a more positive response/ greater agreement)	Z Value: Rank Sum All Students	Z Value: Rank Sum Male Students	Z Value: Rank Sum Female Students
To what extent did your background knowledge of the 5 engineering disciplines at YSU increase by taking this course (ENGR 1500 only)?	-1.648	-0.621	**-2.373***
To what extent do you feel that the actual time spent in class for ENGR 1500 was interesting?	**-6.376*** **	**-4.881*** **	**-4.452*** **
To what extent do you feel that the actual time spent in class for ENGR 1500 was engaging?	**-8.421*** **	**-6.324*** **	**-5.815*** **
To what extent do you feel that the actual time spent in class for ENGR 1500 was effective for student learning?	**-2.123***	-0.236	**-3.794*** **
How often did you find yourself distracted during class for ENGR 1500? (i.e. wanting to check your phone, studying, etc.)	**-6.936*** **	**-6.377*** **	**-2.418***
* denotes p<0.05, ** denotes p<0.01, *** denotes p<0.001			

Table 5. Comparison of Student Responses: Original (2013) & Redesigned Course (2014)

for female students than male as shown in Table 4, to the left, which reports the mean values on a 5 point Likert scale.

The course was managed by the same faculty member for both the original and redesigned course administrations. The original course only had 1 instructor (and guest lecturers) for all students, while the redesigned course had 5 instructors one of whom was the same as the original course offering. In the newly designed course, the students did not have a single course instructor rather they interchanged and had all 5 instructors on a rotating basis. The same survey questions related to perceptions of the course were compared using a Wilcoxon Rank Sum test for both the original and redesigned versions of the course and are summarized in Table 5, to the left below. In terms of background knowledge gained through a lecture based or partially flipped classroom there was no statistically significant difference. The student perception of the classroom experience was statistically different in all other categories. Students in the redesigned course rated it higher in terms of: interest, engagement, and effectiveness for student learning. Additionally students were less likely to indicate they were distracted during class in the redesigned course than the original. Comparisons for male and female differences were also reviewed. Women in the redesigned course rated the background knowledge gained higher than the original. The only other difference noted was that there was not a statistically significant difference in the perception of male students between administrations in reporting effectiveness of student learning.

Students were also asked how they felt the course influenced their plans for selecting an engineering discipline for future study. There was no statistically significant difference between the responses in 2013 and 2014, and no gender differences. As part of the course surveys, students indicated the engineering discipline they were most interested in at three points during the school year: (1) at the start of the fall semester (prior to learning about any of the engineering disciplines in class), (2) at the end of the fall semester, and (3) in the middle of the spring semester when they officially "declare" which field of engineering they plan to pursue. In tracking students selections, in 2013 22% of students changed majors from their original selection while in 2014 33% of students changed majors. Students were also asked how certain they felt about their engineering discipline selection shown in Table 6, below, and there was a statis-

Survey Questions	2013 Mean Student Responses				2014 Mean Student Responses				2013 vs. 2014
Likert Scale (higher values indicate a more positive response/ greater agreement)	All Students (204)	Male (167)	Female (37)	P Value: Rank Sum Male vs. Female	All Students (192)	Male (145)	Female (47)	P Value: Rank Sum Male vs. Female	P Value: Rank Sum 2013 vs. 2014
Did this course, ENGR 1500, influence your plans for a future engineering discipline? (4 point scale)	2.89	2.91	2.78	0.76	2.84	2.80	2.95	0.17	0.46
How certain do you feel about your engineering discipline selection ? (5 point Scale)	4.34	4.34	4.35	0.94	4.40	4.42	4.30	0.21	0.03*
* denotes p<0.05									

Table 6. Certainty of Engineering Discipline Selection

Likert Scale: 1 Lowest Value - 5 Highest Value	Quality		Helpful		Relevant	
	Count	%	count	%	count	%
0 -I was not able to watch	48	5%	48	5%	47	5%
1 - Very low / poor	0	0%	4	0%	0	0%
2 - Somewhat low / poor	13	1%	20	2%	19	2%
3-Neutral	184	20%	157	17%	113	13%
4 - Somewhat high / helpful / relevant	408	45%	348	38%	288	32%
5-Very high / helpful / relevant	253	28%	328	36%	433	48%
	906		905		900	

Table 7. Student Reaction to On-Line Videos

tically significant difference between 2013 and 2014 (more certain of their major selection in 2014), there were no statistically significant differences by gender. The goal of the course was to encourage informed decision making in selecting the "right engineering major" early on to increase persistence and decrease time to graduation. Researchers will not know if this goal has been reached for 3-4 years to determine what percentage of students graduated in the major they indicated initially as First-Year Students and what percentage of major changes occur for upper division students.

This newly designed course is administratively labor intensive and in the short term does not show a difference in the percentage of students that switch majors in the First-Year. However, it has a high approval rating from students and they do indicate that they feel they have a better understand the different engineering majors and feel more certain of their selection. It is hypothesized that long term, students will be less likely to change engineering majors in the future but that data is not yet available.

Student Reaction to the Videos

During the first five weeks of the course when students were rotating through the different engineering disciplinary hands-on sessions, students were asked in a survey about the quality, helpfulness, and relevance of the 5-10 minute video that they watched related to that engineering disciplinary session (they watch the related video in preparation for the upcoming class session). A summary of all student responses across all five weeks is summarized in Table 7, above.

Each week, ~5% of students reported that they did not watch the video in advance of class. Overall, the vast majority of students rated the videos in the highest two categories (somewhat to very high/helpful/ relevant). While these survey responses were quite positive, the qualitative free response items offer further insight. The following 3 quotes show that some students are not engaged with watching videos and offered a couple of suggestions as to what we can add that they would like to see.

"When I watched the video I found it boring. That's probably because that's not what I am interested in. I did think it explained the mechanical engineering discipline."

"I felt that it was slightly dry and didn't go into too much detail. I would have liked to watch a video of student projects, students in the classroom, and maybe an actual engineer on the job."

"No strong feelings either way. I am generally unresponsive to videos."

While other videos reinforced the high scores reported in the surveys:

"The video that I watched about chemical engineering really gave me a clear understanding of what the discipline of engineering actually is. I wasn't sure what it was completely, but watching the video helped me understand what it is. I still plan on Mechanical Engineering for now, but the video for chemical engineering helped me understand it significantly better."

"I was amazed at how much a civil engineer actually does. I thought that they just worked on bridges and roads, I was unaware that they basically work on all of the world's infrastructure."

In the end of semester interviews, most students indicated that the videos were nice to have available for supplemental information; however, it was not the most formative element of the course.

Discussion / Conclusions:

Revisiting the originally proposed research questions:

1) *Through which course structure did students gain a higher level of background knowledge of the different engineering disciplines?*

   There is no statistically significant difference between the original course and the redesigned (partially flipped) course in terms of background knowledge gained.

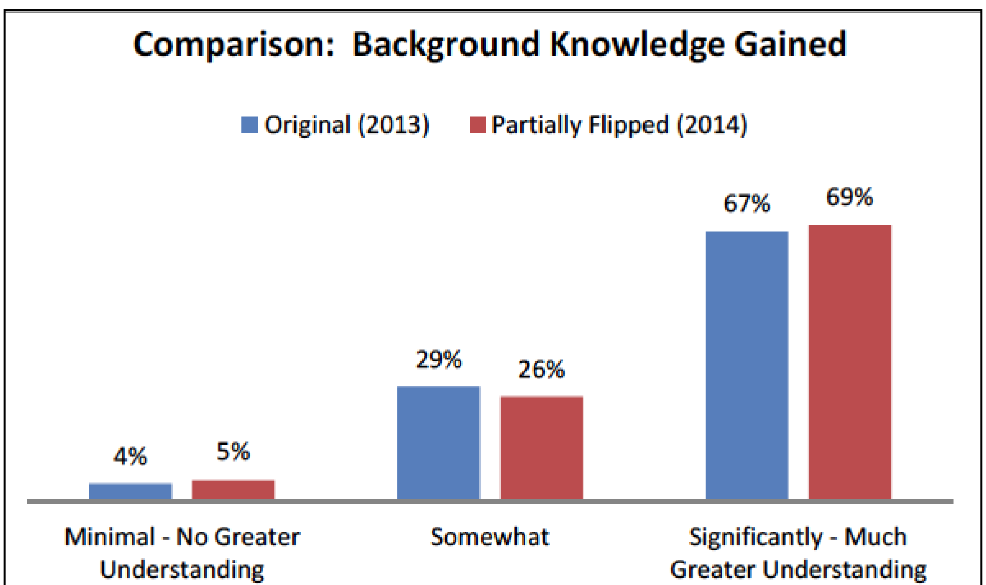

Figure 2. Comparison of the Background Knowledge Gained by Year

2) Which course structure was more effective for student learning?

The newly designed, partially-flipped course was more effective for student learning, especially for women (statistically significant). Figure 3 shows how male and female students rated the course in terms of effectiveness, there were gains for male students (3a) but even higher gains for female students (3b).

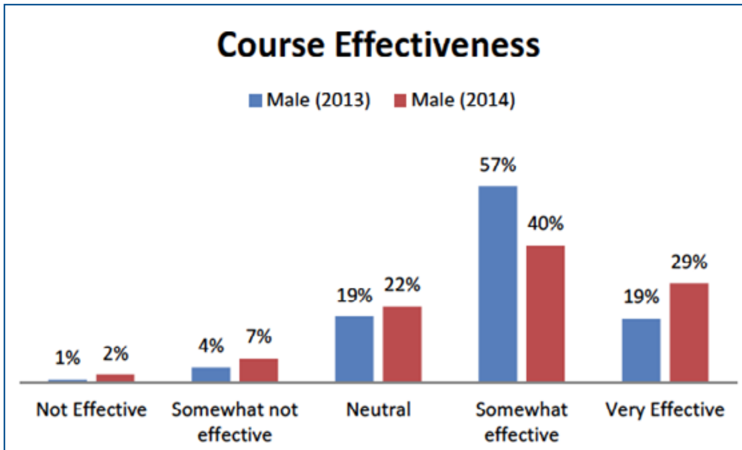

Figure 3a.Course Effectiveness- Men

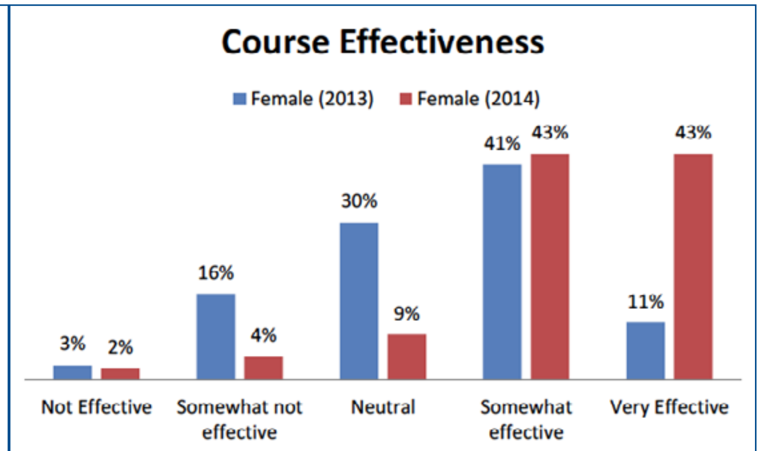

Figure 3b. Course Effectiveness-Women

3) Which course structure yielded higher student interest?

The newly designed, partially-flipped course was deemed more interesting by students (statistically significant).

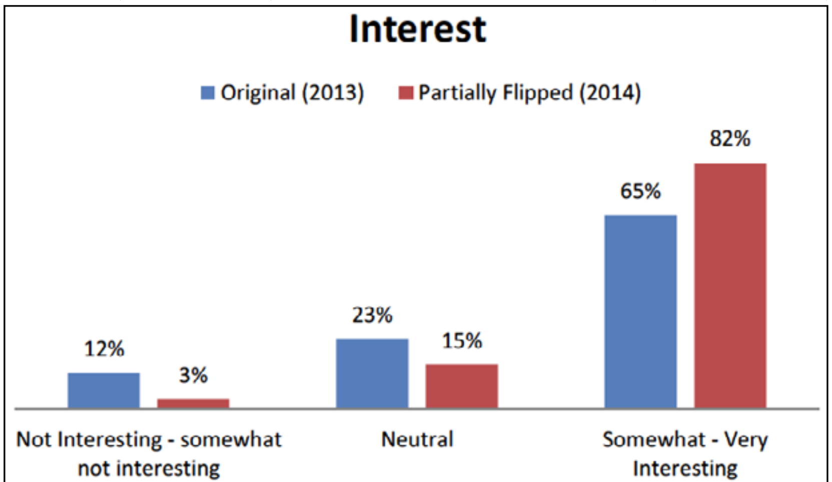

Figure 4. Student Interest Comparison Between Original and Partially Flipped Classroom

4) Which course structure had a higher level of:

a. Student engagement?

The newly designed, partially-flipped course was deemed more engaging for students (statistically significant).

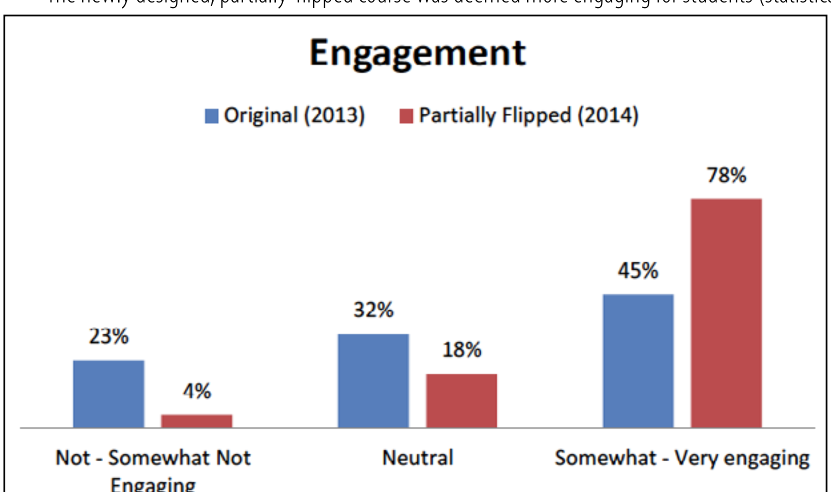

Figure 5. Student Engagement

b. Distraction?

The original course had a higher percentage of students that indicated they felt distracted during class sessions (statistically significant).

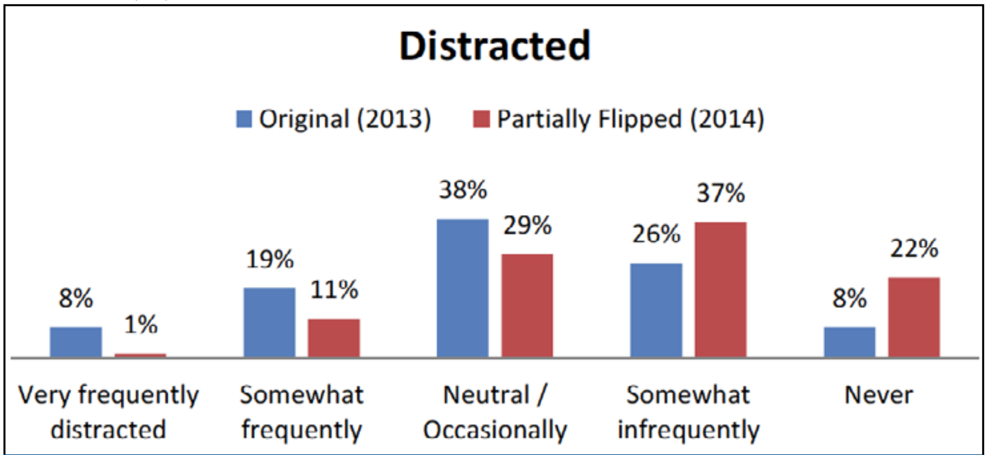

Figure 6. Student Distraction Level

5) *Through which course structure did students indicate a higher degree of certainty of their engineering discipline selection?*

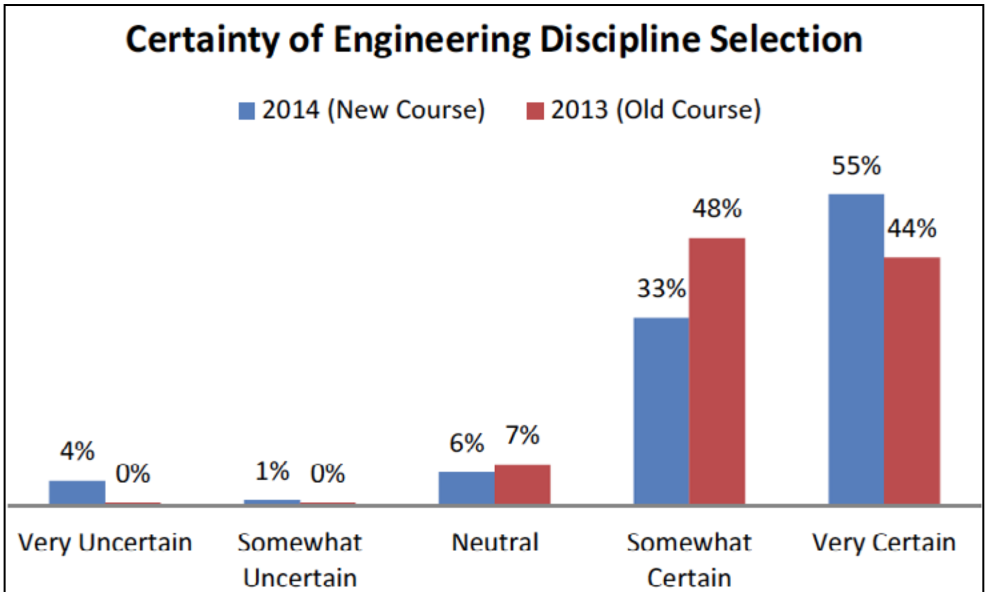

Figure 7. Certainty of Engineering Discipline Selection

Concluding Remarks

The original course was rated much lower by female students than male students -- the course redesign was an improvement for women certainly, but all students (male and female) rated the newly designed course higher. Forming meaningful contacts in a large lecture setting is more challenging than a 20-25 person interactive class where students develop relationships with their peers and faculty, the two most critical factors for college success (Astin, 1993). So it seems that what is better for the women students is better for all students.

Engineering educational innovation is needed nationwide; however, not every new approach is necessarily an improvement. Consideration to the content and context of the material presented should drive decision-making. Prior studies indicate that it may not make sense to flip all areas of a course or all content and that it is not essential for a course to be 100% flipped and there may be certain elements that would be more effective than others (Scwartz, 2013; Velegol, 2015), the current study showed that a partially flipped classroom can be an effective redesign to a course. In the case of engineering major selection, a partially flipped classroom is deemed an effective approach. Administrators may question the resources devoted to implementing a multi-section version of an engineering orientation course because of the associated resources and staffing needs; however, it is not suggested that this model is one size fits all. Rather, this approach can be applied / modified to the selection of an engineering major within the context of an programs structure, size, and student needs (certain program structures may be more conducive than others).

A primary objective of First-Year Engineering Programs is informed selection of an engineering major, and this model was shown to increase student certainty in the selection of their engineering discipline. A higher percentage of students did shift to other engineering programs while taking this course than in the original course; however, future study is needed to assess the number of students that switch majors within engineering (after starting within their program) in subsequent years of study to determine if this approach to informed selection of an engineering major indeed shortened time to graduation or increased persistence.

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