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Student Motivation in a Peer Designed and Delivered Course

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Abstract

This research paper delves into the impact that a unique, student-centered learning experience has on student motivation. Educators often attempt to focus on instructional tools that enhance motivation to excite students about learning and encourage them to become self-taught, lifelong learners. Under the assumption that students understand what motivates their peers best, a team of students, supervised by faculty, designed and taught an introduction to engineering course. This pedagogical approach, coined Peer Designed Instruction (PDI), proved useful and was maintained in this introduction to engineering course.

Couched in the Collaborative Learning literature, PDI deviates from current collaborative learning approaches in one notable way: the authority in the classroom shifts from the faculty member(s) to Student Instructors (SI). These Student Instructors are students that previously completed the course and returned to take on the responsibility for the design and delivery of learning experiences in the classroom. Faculty, therefore, assume a coaching role with the SIs and no longer act as the source of knowledge, educational material, and content delivery for the course.

This research paper delves into the impact that this learning experience has on student motivation. Using a survey developed based on the MUSIC Model of Academic Motivation Inventory®, the authors asked students to report their level of motivation in the introduction to engineering course implementing PDI as compared to their general university experience. Students reported a higher level of motivation in the MUSIC constructs of *empowerment*, *success*, and *caring* for the course using PDI and the same level in the areas of *usefulness* and *interest*. When comparing SI's vs. Non-SI's, no statistically significant difference in motivation was reported. When considering gender, there was no statistically significant difference between female and male respondents in the scales of empowerment and success. Female identifying students did feel that that the course implementing PDI was more useful than male identifying students. Similarly, female students felt that both the intro and the other courses were more interesting than male students. Finally, female students thought the intro course was more caring than the male students. Overall, students surveyed reported that they liked PDI. As a result of this study, enabling students to be instructors is a viable approach for improving student motivation in introductory engineering courses.

Introduction

Identifying and tapping into what motivates students is touted as a key to true learning and student persistence [1]. Educators, therefore, attempt to focus on instructional tools that enhance student motivation to excite students about learning and encourage them to become self-taught, lifelong learners. To this end, a unique pedagogical approach has been developed and implemented in an attempt to increase student motivation in engineering courses. The genesis of this pedagogical innovation was in the fall of 2013. At that time, faculty from the Department of Engineering Education and Leadership (E-Lead) taught a required Introduction to Engineering Leadership seminar course. However, retention in that course was low and the students that remained heavily critiqued the course. Because E-Lead seeks to emphasize student leadership development by encouraging students pursuing a Bachelor of Science in Engineering Leadership (BSEL) to take ownership of not only their education but also the education of their peers, the faculty offered the students critiquing the course an opportunity to perfect the curriculum and instructional methods. Therefore, a team of students, supervised by faculty, designed and taught a new Introduction to Engineering Leadership (Intro to E-Lead) course in fall 2014. This course successfully increased the retention rate of the zero-credit course from 60% to 92% in one semester [2]. The students teaching the course demonstrated strong improvements in their leadership capacity and capabilities and, anecdotally, students participating in the course enjoyed the peer instruction model and found it a more motivating learning environment [2]. As a result of these early successes, this pedagogical approach, coined by the authors as Peer Designed Instruction (PDI), has been maintained in the Intro to E-Lead course.

This PDI approach is couched in the Collaborative Learning literature [3]. In essence, collaborative learning includes those techniques that encourage students and instructors to learn *together*. In Peer Instruction, for example, students are called upon to take responsibility for learning by being prompted by a faculty member to engage in a group discussion around a complex question proposed during a lecture [4]. However, Peer Designed Instruction deviates from current Collaborative Learning approaches in one notable way: the authority in the classroom shifts from the faculty member(s) to Student Instructors (SIs). These Student Instructors are students that have previously completed the course and have returned to take on the responsibility for the design, content, and delivery of learning experiences in the classroom. Faculty, therefore, assume a coaching role with the Student Instructors and no longer act as the source of knowledge, educational material, and content delivery for the course.

However, because of the early success of using PDI and its potential for increasing student motivation, a study is needed to further delve into the impact that such a learning experience has on students and validate the approach. This paper focuses on the outcomes from surveying students about their level of motivation in the course, through the use of the MUSIC Model of Academic Motivation Inventory® [5], as compared to their other coursework and their perceptions of having peers as instructors.

Implementation of Peer Designed Instruction

The Peer Designed Instruction approach has been implemented four times in the Department of Engineering Education and Leadership at the University of Texas at El Paso (UTEP). Founded in 1914, UTEP is recognized nationally for its academic programs that serve a largely Hispanic, first generation college student population. The population of the region is predominantly of Mexican ancestry and modest economic means, and the majority of its students are the first in their families to seek a university education. The campus draws over 90% of its students from its region. The student body is composed primarily of Hispanic (80%), White Non-Hispanic (8%), and African-American (2.7%) [6]. According to the 2014 United States Bureau of Economic Analysis report, only 12% of the region's inhabitants hold a college degree. It is in every sense a campus setting spearheading new and innovative instructional approaches to meet the needs of a non-traditional student body that is largely bilingual and bicultural and has uniquely tapped the essence of a bi-national socio-economic community.

Rapid engineering advances in the 21st century have led to scientific, medical, and technological breakthroughs that require engineers to work in multidisciplinary teams and to develop broad, interdisciplinary knowledge. Therefore, the E-Lead program at the focus of this research offers a rigorous yet flexible major in Engineering with an in-depth study of leadership and its effect upon engineering and society. The program strives to satisfy a long-term need for a new kind of engineer: one with excellent communication skills, business acumen, and leadership abilities (www.e-lead.utep.edu).

The target course for PDI implementation was the Intro to E-Lead course mentioned previously. This course is a predominantly non-technical course for which the primary goal is for students to acclimate to the E-Lead program and focus on developing their personal identity and critical skills for success in engineering. As such, this course is a zero-credit course for incoming students. The assumption behind using this instructional approach in this course is that students can better empathize with their peers and will, therefore, better understand what incoming students need to know to be successful, as well as how to deliver the content. Also an author of this paper, the same faculty member implemented this approach in the Intro to E-Lead course in the fall 2015, spring 2016, and fall 2016 long semesters. Another faculty member offered the course using the PDI approach in the fall of 2014. What follows is a description of the process used to recruit Student Instructors (SI), mentor SI students through curriculum development, and supervise material delivery in class.

Teaching Team Formation – The selection criteria for inclusion on the teaching team comprises expressed interest, successful completion of the course, enrollment in the E-Lead program, and, when possible, an even distribution of gender and academic classifications. On average, teaching teams included one faculty member supervising four to five SIs. Ideally, each teaching team consists of one to two experienced SIs to mentor one to two new SIs. Students are recruited a few weeks before the start of each semester and are paid hourly for their efforts. To date, we have been able to accept all students that have applied.

Curriculum Development – To develop the learning goals and related curriculum, Student Instructors participate in a series of curriculum development workshops organized by the supervising faculty member. During these workshops, the SIs are given a core set of learning objectives, as identified by the department, around which to create a set of activities, artifacts, and assessments. As shown in Table 1, the teaching team is also encouraged to add learning objectives for anything they wish they had known coming into the program as well as anything they felt was not covered well when they took the course. In the fall semesters of 2015 and 2016, the Intro to E-Lead course also incorporated a two-credit hour fundamentals of engineering graphics course. In holding with the teaching styles of other courses in the E-Lead program, the SIs are encouraged to not rely solely on lectures as their method of content delivery but to explore other active learning techniques. As a result, the curriculum is continually evolving to address the perceived needs of incoming students while maintaining a few key elements.

Course Instruction – Before each class period, the teaching team is required to develop a lesson plan. In the lesson plan, SIs assign responsibility for delivering content and leading activities.

During class, one SI leads while the other SIs assist. At a minimum, two SIs are responsible for content delivery each period and leadership rotates through the group each period.

Table 1 - Course Learning Goals Identified by Student Instructors (Italics are department requirements)

Fall 2014	Fall 2015	Spring 2016	Fall 2016	Spring 2017 (proposed)
Program Orientation	*Program Orientation*	*Program Orientation*	*Program Orientation*	*Program Orientation*
Leadership Identity	*Leadership Fundamentals*	*Leadership Fundamentals*	*Leadership Fundamentals*	*Leadership Fundamentals*
Innovative Thinking	*Communication Skills*	*Communication Skills*	*Communication Skills*	*Communication Skills*
Hands-On Skills	Hands-On Skills	Hands-on Skills	Hands-on Skills	Hands-on Skills
	Personal Identity	Personal Identity	Personal Identity	Personal Identity
	Teamwork	Program Community Development	Program Community Development	Teamwork
	Engr. Graphics		*Engr. Graphics*	Critical Thinking

In this model, the primary role of the faculty member is to lend credibility to the teaching team and aid in classroom management. Therefore, the faculty member remains present during instruction but takes on a passive role. Often, the faculty member will remain quiet at the back of the room or will join in as a non-instructor participant in activities. The faculty member will occasionally supplement instruction if it appears that the SI has given confusing or conflicting information. Early in the semester, the teaching team explains the design of the course and roles of the teaching team members to enrolled students to help them adjust to the teaching style.

Grading – Grading of artifacts from students is a joint effort of the SIs and the supervising faculty member. As a zero credit course, most assignments have binary completion grades. However, some assignments do have a letter-grade assigned to provide both summative and formative feedback. For each graded assignment, the SIs develop a rubric that is approved by the faculty member and shared with students in advance. The SIs and faculty member then grade submitted assignments using the rubric. The faculty member determines the final grades.

Continued SI Skill Development and Accountability – As most of the SIs have had minimal prior teaching experience, the faculty supervisor, other SIs, and students in the class provide regular training and feedback. Weekly teaching team meetings are held to provide feedback on the prior week's instruction as well as prepare for the upcoming week. Periodically, the SIs also solicit feedback from the students in the course on how they can improve their teaching.

Methods

After having implemented Peer Designed Instruction in the Introduction to Engineering Leadership course four times, a study was developed to answer the following research questions:

1. What are student perceptions of Peer Designed Instruction?
2. Does Peer Designed Instruction increase student motivation when compared to other courses students have taken at the University of Texas at El Paso?
3. Does motivation in this context change based on gender?

4. Does motivation in this context change based on the student having been a Student Instructor?

To answer these questions, a mixed-methods approach was used to collect student feedback via a three-part survey. In the first part, a series of multiple choice and open-ended questions were included to allow students the opportunity to reflect on their experience. Questions one through ten are a set of introductory open-ended questions related to the participants' demographic data, academic classification, the semester in which they enrolled in the course, whether or not they were a Student Instructor for the course, and whether they were still pursuing a BSEL.

Following these introductory questions, participants are asked to respond to a series of Likert-style questions and, when appropriate, open-ended follow-up questions (part 2). These 14 questions primarily focused on participant perceptions of students as instructors, their learning in the course, and the utility of the course in helping students both develop as leaders and understand the E-Lead program (Appendix A). For those students that were SIs, four additional questions related to their experience are asked (Appendix A questions denoted by an asterisk).

A brief survey of motivation literature provided guidance for developing the assessment plan of student motivation (part 3). Several theories exist for describing factors contributing to student motivation [7]. Among some of the popular motivation theories in the engineering education literature are those of Self-Determination, Expectancy-Value, and Social-Cognitive theories of student motivation. The Self-Determination Theory of motivation assumes that students are motivated intrinsically by their feelings of competence, autonomy, and relatedness in their learning [8-9]. Stolk and Martello, for example, used this theory of motivation to assess the impact of disciplinary integration in a project based engineering course [10]. The Expectancy-Value theory describes motivation based on the idea that a student's expectation of resulting outcomes from a given activity, and the value they ascribe to those outcomes, influences their motivation [7]. Jones et al., for example, used the Expectancy-Value theory in describing the persistence of first-year engineering students [11]. The Social-Cognitive Theory (SCT) describes student motivation as being tied to self-regulation within an environmental context. In other words, according to SCT, the tendency for students to regulate their motivation is based on their evaluation of their activities, the performance of those activities, and how they react to their level of performance [7,12]. This model was used by Nelson et al. to assess motivation of introductory computer science students [13].

A variety of scales exist to assess motivation based on these frameworks. Guay et al. used the Self-Determination Theory in the development of the Situational Motivation Scale (SIMS) [9]. The SIMS includes sixteen questions related to intrinsic motivation, identified regulation, external regulation, and amotivation. Jones used the Social-Cognitive Theory in the development of the MUSIC Model of Academic Motivation Inventory® [5,14]. The MUSIC Inventory® includes the constructs of empowerment, usefulness, success, interest, and caring.

In this study, the assessment of student motivation is based on the Social-Cognitive Theory of motivation [12]. This theory was selected because it accounts for the interaction of the student with the environment and guides development of environmental interventions instructors can use to improve motivation [5]. As the PDI approach predominantly aims at modifying the students' learning environment to increase motivation, this theory seemed most appropriate for this study.

Further, in considering available scales, the structure of the MUSIC Inventory® questions more directly allowed overall course motivation comparison than the SIMS while still incorporated elements of autonomy, relatedness, and competence inherent in the Self-Determination Theory of the SIMS. Therefore, in this study, student motivation is assessed based on the Social-Cognitive Theory using the MUSIC Inventory®.

Therefore, to assess student's perception of their motivation, participants are asked to complete the MUSIC Inventory® [14] in the third part of the survey. The 25-item MUSIC Inventory® includes the constructs of empowerment (4 questions), usefulness (5 questions), success (4 questions), interest (6 questions), and caring (6 questions). Students are asked to complete the instrument twice, once for each of the following prompts: "Thinking about the *Intro to Engineering Leadership* course you have taken, please rate your level of agreement or disagreement with the following statement:" and "Thinking about your *general experience in the University of Texas at El Paso courses* you have taken, please rate your level of agreement or disagreement with the following statement:". Responses were recorded on a scale from 1 to 6, where 1 is *strongly dissagree* and 6 is *strongly agree*.

Recruited participants include all students previously enrolled in the course, as of the university's census date each semester, in the Introduction to Engineering course during fall 2014 through fall 2016. Therefore, 105 students (of which 17 were SIs, 7 of which have not been students in the course when taught using the PDI model) were recruited via email to complete the survey online using Qualtrics. Students were sent periodic emails reminding them to complete the survey and offered a small incentive, in the form of a candy bar, for completing the survey.

Results

Demographic Data. Of the 105 invitations to complete the survey, 41 participants initiated surveys, of which 33 were submitted. Of the 33 responses, only 26 were complete and eligible for inclusion in the study. Those responses excluded were either incomplete, from a respondent under the age of 18, or the respondent did not consent to participate. Table 3 summarizes the demographic breakdown of the participants included in the study. Of study participants who self-reported their race, 15 reported to be Hispanic/Latino, 3 White, 1 African American, and 6 opted not to report (Table 2). Therefore the distribution of self-reported race was 58% Hispanic (75% of those reporting race), 12% White, 4% African-American, and 23% preferred not to report. The high number of students that opted not to identify their race does skew the distribution away from that of the university, where the student population is 80% Hispanic, 8% White Non-Hispanic, and 2.7% African American [6]. The E-Lead program as a whole is 89% Hispanic, 10% White, and 2% African American. One possible explanation for these disparities is due to allowing students to self-identify via an open-ended question, rather than select from a list of options. Further, outside of consenting to participate and providing their age, none of the questions in the survey were required. Together, these factors likely led to the high percentage of students not reporting their race. Of those that reported a gender identity, 42% were female. This percentage is higher than is typically seen in engineering programs at UTEP where the average is approximately 20% [6]. However, the E-Lead program is 39% female as of fall 2016 and therefore the relatively high percentage of students identifying as female was not unexpected.

Table 2 - Participant Demographic Data

	All Participants	SI	Non-SI
Female	11	3	8
Male	15	2	13
Ave. Age (STDV)	20.4 (2.3)	20.4 (2.8)	20.4 (2.2)

Of the students that enrolled in the course, and therefore recruited for the study, 25% responded to the survey (Table 3). Of the 17 SI's, 29% responded to the survey.

Table 3 - Response Rate

Course	Study Participants	Course Enrollment	Percent Represented
*Fall 2013**	1	7	14%
Fall 2014	1	29	3%
Fall 2015	10	37	27%
Spring 2016	4	5	80%
Fall 2016	10	27	37%
Total Recruitment	**26**	**105**	**25%**

**Fall 2014 SIs only*

Research Question 1: Student Perceptions of Peer Design Instruction

Student Reported Learning (Q1). Students were asked what the three most important things they learned in the course were. After careful coding of their open-ended responses, it was clear that their answers coincided with the main goals of the course, as found in Table 1. The top 3 responses were related to *Teamwork* (15 answers), *Leadership* (10), and *Program Orientation* (9). The next most common responses, with six responses each, were *Personal Identity* and *Program Community Development*. *Communication Skills* and *Engineering Graphics* had five responses each.

Community (Q4 & Q5). Since one of the characteristics of the program and goals of the course is to help foster community, students were asked two questions about their ability to connect with both faculty and students in the E-Lead program. Nine students felt that they were able to connect with faculty moderately or extremely well. In comparison, 23 students (88% of respondents) felt that they were able to connect with other students moderately or extremely well (none felt that they were unable to make connections). Students, therefore, feel as though they can build community with other students but not as well with faculty in E-Lead. Therefore, as this is one of the goals of the course, additional steps to help build connections with the faculty in the department is still needed.

Retention (Q6 & Q7). To determine how successful this course was at encouraging students to remain in E-Lead, students were asked: "To what extent did being in the course make you want to stay in E-Lead?" Seventeen students (65%) responded that the course made them want to stay in E-Lead somewhat more or much more. Only four students responded that the course made them want to stay somewhat less or much less. Only one student surveyed did not stay in the E-Lead program but stated that they "did not enjoy any engineering program. I enjoyed the class but not the engineering part. I'm majoring in […] special education K-12." Further, the responses to the open-ended question about how this course helped students make progress towards academic, work, and degree goals provided us with insight on retention. Thirteen responses expressed that the course helped enforce the choice to pursue an engineering career. Seven other responses included comments such as "It has inspired my entrepreneurship", "helped clarify the nature of the program", "it assured me I was in the right place", and "taught me to think outside the box in unique professional ways", clearly indicated their intention to remain in the program specifically because of the leadership and entrepreneurial components. Two students found little to no help with the course helping with their professional goals, and six students did not answer the question.

Student Perceptions of Student Instructors (Q8-Q12). When asked, "How much did you like/dislike having students as instructors?" 73% (19 of 26) of students responded that they liked it (either somewhat or a great amount) while only seven somewhat disliked having students as instructors. When asked about having faculty teach the course, the overall response was that of neutrality; where six reported that they would not prefer that faculty teach the course, six reported that they did, and 12 said maybe.

When asked what they liked about having students as instructors, 11 respondents stated that having SIs was more "personable" or "very friendly and always there for you". Eight responses expressed how having SIs as instructors was a more "comfortable" experience because they were more "approachable" and "more accessible". Four comments related to how SIs as instructors also shared their personal university experiences and "passed down what they learned", "share their story", and valued "their advice on school, career and personal matters". Four responses were blank or neutral. On the other hand, when asked what they disliked about having students as instructors, the most prevalent reasons (at least 10) for not liking students as instructors dealt with unpreparedness, disorganization, and unclear expectations. Six responses included comments such as "unqualified", "did not know the software", and "unassertive". Four responses included that SIs were "playful", "distracted", or "not there". There were four blank responses.

Improving Course Instruction (Q13). The recommendations regarding *instructors*, included less SIs, hire older SIs, and have "professor to lead the course and have SIs as secondary instructors". Others recommended to "give training to students beforehand" and to be "well prepared". As for *course organization,* most responses on improving the course, not surprisingly, included greater course organization and clear syllabus: "be organized", a "well defined" and "detailed syllabus", "clearer grading criteria", "more structure", and better coordination between professor and student instructors. As to *course content,* three comments (two from SIs) recommended teaching the Intro to E-Lead course separate from the graphics material: "definitely do not have the same graphic skills as the engineering students in other departments", and "it is bad to teach the design course with the intro course". Three suggestions for improving the course stressed more focus on engineering content and engineering projects.

Student Instructor Perceptions of Peer Designed Instruction (Q15-18) Survey questions 15-18 were asked exclusively of the students who took the course and later served as SI (5 responses). Of the 5, three were female, and four had served as SIs for at least two semesters. Interestingly, the SIs had unique comments regarding their challenges in assisting with instruction: "not an expert and couldn't always answer the questions", "what was important to have in the curriculum and what wasn't", "not falling in lecturing mode", and "drawing a boundary between being their instructor and being their friend". Feedback received from SI's regarding how they handled conflicts included two responses focused on using communication as the means to resolving the problem. As one participant stated, "talk to them on a personal level to understand the conflict, " and another one stressed the importance of remaining "unbiased after looking at both sides". Mentoring was the most common response from SIs when asked about what they liked regarding their experience as SI for the course: "help people [students] directly", "constantly ask me for help", and "helped shape their views about engineering and college". The second most popular response was that they enjoyed "meeting everyone" in the program, and "getting to know incoming students". Other positive comments included "having a job that is actually worth the time" and being an SI "made me feel like they [students] could trust me". The only dislike came from one female SI who expressed that she "did not like the different levels of motivation" when referring to the SI team.

Opinions of the involvement and preferences of SIs from the open-ended questions posed to the SIs included "students do not know how to juggle multiple roles", "it allows for a fun and relatable learning experience", and "students must be well prepared and organized for instruction to be effective". One SI respondent indicated that the course was "better when students taught it than when faculty was in charge." When asked about the three most important things learned in the course, four of the five responses from SIs considered "team work" as the most important thing they learned. Interestingly, the items listed are more skills rather than content: "being open minded", "character", "capacity", "importance of self-development", "time management", and "presentation skills". Although only three SIs expressed how the course has helped them progress towards their professional goals, two of them found the course enlightening and reaffirmed their program selection.

Additionally, the faculty supervisor has informally observed that there is a strong relationship between the quality of the teaching team and the motivation of students in the course. In future studies, it would be interesting to assess the quality of the teaching team and determine how much of an impact it has on student motivation. The one student that wanted the faculty back as instructors could be due to quality issues with that particular teaching team, rather than with the instructional approach as a whole.

Research Question 2: Differences in Motivation of Peer Designed Instruction Course Compared to Other University Courses

Student Motivation (Q14; MUSIC Inventory®). When directly asked "Comparing this course to your other University of Texas at El Paso courses taken, to what extent do you find this course MORE motivating to engage in learning?", 17 students reported that it was either "a lot" or "a great deal" more motivating. Only one student responded that it was not more motivating. However, to more accurately measure student motivation of this course against other courses students had taken, additional questions were asked based on the MUSIC Inventory® developed by Jones [5,14]. Students responded to each question in the 25-item motivation scale twice, once for the Intro to E-Lead course and once for their general experience in UTEP courses.

Table 4 summarizes average student responses for each scale. Assuming a *p*-value < 0.05 is significant, there was a statistically significant increase in overall motivation in the Intro to E-Lead course as compared to other UTEP courses. Of the specific MUSIC scales, *empowerment*, *success*, and *caring* had significantly higher scores for the Intro to E-Lead course than other UTEP courses. *Usefulness* and *interest* did not. This lack of perceived usefulness is not surprising since students perceive the content as easy and the faculty often get reports from students wishing there was more engineering content. Instead, the most important learning reported by students, in response to survey question one, was about personal identity development and professional skills, such as leadership and team working skills, rather than technical content. Therefore, future iterations of the course will need to attempt to understand why students do not feel that the content of the course is useful or interesting. An attempt at increasing the level of usefulness, being implemented in fall 2017, is to no longer offer the course as zero-credit but for-credit. Technical content could, of course, be added since students seem to feel that it lacks in the course. However, it would be interesting to see if we could increase students' feelings of usefulness and interest without having to increase the level of technical content in the course. As previously noted, the Intro to E-Lead course was not a technical course; though two offerings of the course did include a heavy emphasis on engineering graphics. Therefore future research will need to focus on how to implement PDI effectively in a more traditional engineering course.

Table 4 - Student Motivation (n=26) in Intro to Engineering Course and Other University Courses

Scale	Intro to E-Lead Course	Other Univ. Courses	*p*-value
eMpowerment	5.12	4.64	<< 0.001*
Usefulness	4.81	4.84	0.60
Success	5.49	5.20	<< 0.001*
Interest	4.74	4.59	0.095
Caring	5.29	4.94	<< 0.001*

Research Question 3: Gender-Based Differences in Motivation

When considering gender, however, there is a difference in how participants reported motivation (Table 5). For respondents that identified as female, they reported a significantly higher level of *empowerment*, *success*, and *caring* in the Intro to E-Lead course, but not in *usefulness* or *interest*. For male-identifying respondents, results were similar, but *success* became slightly insignificant. In the scales of *empowerment* and *success*, there was no statistically significant difference between female or male respondents. Further, female students felt that the Intro to E-Lead course was more useful that male students. Similarly, female students felt that both the intro and the other courses were more interesting than male students. Finally, female students thought the Intro to E-Lead course was more caring than the male students.

Table 5 - Comparison of Student Motivation Across Self-Reported Gender Identities (n=11 Female, n=15 Male)

Scale	Female Intro	Female Other	*p*-Value	Male Intro	Male Other	*p*-Value	*p*-Value Intro (F - M)	*p*-Value Other (F - M)
eMpowerment	5.15	4.80	0.01*	5.11	4.52	<< 0.001*	0.79	0.14
Usefulness	5.04	4.96	0.48	4.64	4.75	0.32	0.01*	0.15
Success	5.52	5.14	0.001*	5.46	5.24	0.06	0.56	0.52
Interest	4.95	4.95	1.00	4.58	4.31	0.07	0.02*	0.001*
Caring	5.47	5.03	0.001*	5.13	4.66	<< 0.001*	0.01*	0.06

Research Question 4: Differences in SI vs. Non-SI Student Motivation

When considered independently, the SIs' vs. non-SIs', SI scores followed the same trend as non-SIs. Of the specific MUSIC scales, *empowerment*, *success*, and *caring* had significantly higher scores for the Intro to E-Lead course than other university courses. *Usefulness* and *interest* did not. Further, there is not a statistically significant difference between the SIs' and the Non-SIs' scores (Table 6). In other words, the motivation trends were similar for SIs and non-SIs.

Table 6 - Comparison of Motivation of Student Instructors (n=5) vs. Non-Student Instructors (n=21)

Scale	SI Intro	SI Other	*p* Value	Non-SI Intro	Non-SI Other	*p* Value	*p* Value (SI vs Non-SI Intro)	*p* Value (SI vs Non-SI Other)
eMpowerment	5.24	4.56	0.01*	5.10	4.66	<< 0.001*	0.42	0.66
Usefulness	5.00	5.08	0.68	4.76	4.79	0.70	0.22	0.10
Success	5.70	5.20	0.01*	5.43	5.20	0.01*	0.05	0.98
Interest	4.77	4.47	0.19	4.74	4.62	0.24	0.87	0.55
Caring	5.53	4.86	0.001*	5.21	4.81	<< 0.001*	0.05	0.83

Study Limitations

Sample Size. With a 25% response rate, one major limitation of this study was the small sample sizes, particularly of the SI's. Future work, therefore, should focus on increasing sample sizes to increase the statistical power during analysis. A possible explanation for the low response rate could be the timing of the study. Students received the invitation to complete the survey via university email close to the beginning of winter break. Therefore, more students may have responded to the university e-mail during the semester rather than on break. Also, students who have left the program or the university may no longer check their university email account or email from the department.

Variations in Content, Class Size, and SI Teams. Another limitation of the study is the variation in content and teaching team each semester. Each semester the content evolves based on the perceived needs. While this flexibility is a strength of the instructional style, some courses were better designed than others, and this could impact outcomes. In addition, two semesters included engineering graphics content. This material was more technical in nature and often delivered separately from the Intro to E-Lead content. Further, course sizes have also varied even when the number of SI's has remained consistent each semester. Therefore, the in-class dynamic could have been very different for those students that experienced a higher student to SI ratio.

Timing of Assessment. Although assessment of students' content learning was completed throughout each offering of the course, student motivation was not. Instead, all students from past semesters were simultaneously surveyed between the fall 2016 and spring 2017 long semesters. This is, therefore, another limitation of the study as respondents included students that recently completed the course and others that completed it a year or more ago. Future studies should focus on determining an appropriate assessment pattern that accommodates the short and long term effects of the instructional style.

Low Response Rate of Students No Longer in the Program. Even though all students that enrolled in the course were emailed, only one student responded that is no longer in the E-Lead program. Therefore, future research should focus on encouraging students that did not continue with the E-Lead program to respond. This would give a better perspective of what caused them to leave the program and therefore how the course impacts retention.

Vague Answers. With open-ended style questions, students had a tendency to provide vague answers. In future iterations, students should be asked to provide examples as evidence of vague claims.

Conclusion

This research paper delves into the impact that this unique, student-centered learning experience, Peer Designed Instruction (PDI), has on student motivation. Using the MUSIC Inventory of academic motivation [5,14], students were asked to report on their motivation in the Introduction to Engineering Leadership course using PDI as compared to their general university experience. Students reported a higher level of motivation in the constructs of *empowerment*, *success*, and *caring* for the course using PDI and consistent levels in the areas of *usefulness* and *interest*. When comparing Student Instructors vs. Non-SIs, no statistically significant difference in motivation was reported. However, when considering gender, in the scales of *empowerment* and *success*, there was no statistically significant difference between female and male identifying respondents. Female students did feel that that the course implementing PDI was more *useful* than male students. Similarly, female students felt that both the Intro to E-Lead and the other courses were more *interesting* than male students. Finally, female students thought the Intro to E-Lead course was more *caring* than the male students. Most students liked having other students as instructors, and the overall response was that of neutrality when asked if they prefer faculty to teach the course. Students expressed comfort working with SIs mainly because they could relate to them, found them more approachable, and enjoyed their mentorship. The most prevalent reasons for not liking students as instructors dealt with unpreparedness, disorganization and unclear expectations. As a result of this study, enabling students to be instructors is a viable approach for improving student motivation in introductory engineering courses.

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Appendix A - Survey Questions and Types (SI-only questions denoted by asterisk)

Survey Question	**Type/Scale**
1. What do you consider are the three most important things you learned in the course?	Open-Ended
2. How much did this course help you understand the Engineering Leadership program?	Likert, 1 (None at all) to 6 (A great deal)
3. How much did this course help you grow as an engineering leader?	Likert, 1 (None at all) to 6 (A great deal)
4. How well were you able to connect with the E-Lead professors while in the course?	Likert, 1 (Not well at all) to 6 (Extremely well)
5. How well were you able to connect with the E-Lead student community because of this course?	Likert, 1 (Not well at all) to 6 (Extremely well)
6. To what extent did being in the course make you want to stay in E-Lead?	Likert, 1 (Much less) to 6 (Much more)
7. How did this course help you make progress toward your professional goals (academics, work, degree, etc.)?	Open-Ended
8. How much did you like/dislike having students as instructors?	Likert, 1 (Dislike a great deal) to 6 (Like a great deal)
9. What is your opinion of the involvement of students as instructors?	Open-Ended
10. What did you like about having students as instructors?	Open-Ended
11. What did you NOT like about having students as instructors?	Open-Ended
12. Would you prefer that the course be taught by faculty?	Yes-No-Maybe
13. What would you change to improve the instruction of this course?	Open-Ended
14. Comparing this course to your other courses taken, to what extent do you find this course MORE motivating to engage in learning?	Likert, 1 (None at all) to 6 (A great deal)
**15. As a teacher assistant (TA)/Instructor of this course, how much did this teaching experience help you grow as an engineering leader?*	Open-Ended
**16. What were some challenges you had assisting in instruction?*	Open-Ended
**17. As TA, how did you handle conflict resolution?*	Open-Ended
**18. What did you like or dislike about your experience as an instructor?*	Open-Ended