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A Comparative Analysis of Teacher and Student Perceptions of Sources of Motivation in Freshman Engineering Design Courses at Liberal Arts Universities

Dr. Xi Wang P.E., University of Mount Union

Xi Wang is an Assistant Professor of Civil Engineering at the University of Mount Union. She received her Ph.D. and M.Eng both in Civil Engineering from the University of Kentucky and Auburn University. Her research interests include the application of Unmanned Aerial Vehicle in construction management, Lean Construction, and engineering education.

Dr. Minhao Dai, Kennesaw State University
Miss Gabriella Cataloni, University of Mount Union

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Abstract

Liberal arts universities and colleges aim to provide students with an education in problem-solving skills, critical thinking ability, and communication tools. With more liberal arts institutes started to have engineering programs, it is important to understand and evaluate the impacts of engineering curriculum in liberal arts settings on students, faculty, and the programs. Thus, this pilot study examines an introductory engineering design course that aims to enhance the engineering design and engineering disciplines for first-year students in liberal arts universities. Specifically, we examined what learning objectives in this course motivated students. More importantly, the study explored whether these motivations aligned with teacher's perceptions of motivation, and how these motivations varied based on student demographics. The course is designed as a highly interactive seminar-style course that explores all aspects of the engineering profession, including engineering disciplines, education, creativity and design process, and engineers' professional and ethical responsibilities. Students here implement the engineering design process to develop prototypes that solve complex engineering problems, as well as presentations and intensive technical writing. We conducted comparative surveys of teachers and students at a medium-sized liberal arts university in the Midwestern U.S. The results showed that solving real-life problems and teamwork skills are the strongest motivators for students. These findings aligned with teachers' perceptions of what motivated their students in this course. Furthermore, we found some interesting differences in some of the motivations based on gender, race, and student GPA. We hope our results inform more effective design in first-year engineering design courses in liberal arts universities and further improve student retention and graduation rates. We also intend to use this pilot study for a more comprehensive and larger-scale survey research investigating more students.

Background and Motivation

In recent years, more liberal arts colleges established and extended their engineering program offerings through a wide variety of engineering majors. Although engineering courses are practice-and detailed-oriented which is different from the traditional liberal arts curriculum [1], liberal arts colleges believe that integrating the liberal arts education experiences into engineering education would position future engineers to be more successful at anticipating, defining, and solving problems [2]. First, liberal arts engineering education provides a more supportive environment through a small class size. Students have the opportunities of peer interactions as well as interactions with faculty members, and these interactions could encourage more effective understanding of materials and exploration of topics. Second, liberal arts education focuses on cultivating adaptive problem-solving skills based on critical thinking, collaboration, and effective communication. These skills make students valuable collaborators in engineering projects and afford them a smooth transition into professional life [3]. That means a liberal arts education can potentially lead to a successful engineering career.

In the meantime, the integration of engineering education into liberal arts universities poses several challenges to the engineering faculty members. For instance, faculty members may lack the knowledge needed to make curricular connections between the liberal arts and engineering education. In many cases, multiple faculty members from different disciplines create and co-teach courses, which may take substantial time and effort for faculty to sit together to design the curriculum. On the other hand, faculty members might be fiercely proud of their disciplines. They may resist an integrated curriculum that devalues their own discipline while elevating another [2]. No matter what the course is, faculty members should be devoted to creating an effective learning environment and then ensure students achieve designed learning outcomes. Thus, understanding students' motivation for learning is one of the prime factors that contribute to achieving the goal which is creating an effective learning environment [4]. Motivation is the energy or simulation that initiates a process in which individuals make choices [5]. A student's choice to engage in behaviors will contribute to doing well in a class. In other words, student motivation affects learning effectiveness and outcomes [6]-[10]. Thus, if teachers understand factors that affect student motivations or have the same perceptions of motivations as students, it could be a valuable guide for teachers when designing a course. However, the previous literature related to this topic focuses on the disconnection and divergences between engineering and liberal arts education [11]-[14] or offers recommendations on how to integrate liberal arts education in a specific engineering discipline [15]-[18]. To the best of our knowledge, no previous research has examined the differences between faculty and students regarding teaching and learning perceptions in an engineering program at a liberal art college. Therefore, this pilot study sets out to explore the teacher and student perceptions of sources of motivation in an introductory engineering design course in liberal arts settings. The sources of motivation and demotivation are evaluated by students' learning outcomes of the course. Learning outcomes indicate that what the instructor intends for the learning in a course and how the student demonstrates learning in the course [19]. They are directly linked to the design and content of courses.

Engineering Design Course

This pilot study examines one of the most important topics in engineering education, engineering design. Design is widely considered to be the central activity of engineering [20]. One of the most important responsibilities of engineering programs is to train engineers who can design effective solutions to meet the needs of industries and society [21]. However, until now, how to support good design education is still an abysmal topic among engineering faculty members [22]. Engineering design is a systematic and complex process in which designers generate, evaluate, and implement concepts to achieve clients' objectives under a set of constraints. [23][24]. Engineering design course is particularly challenging to teach because of the complex moving parts in engineering design, such as systematic contexts, decision making, and collaboration [25].

But in the meantime, the engineering design could be an effective activity for teaching liberal arts and engineering students how technology and society interact from the perspective of the creator of technology, the designer or engineer [26]. In other words, engineering design acts as a bridge that smoothly connects between liberal arts and engineering education. Most liberal arts universities expose freshmen to engineering design in their first year. On the one hand, first-year students in general lack a clear understanding of the engineering profession and its different disciplines. Students are vulnerable to pursuing majors that diverge from their career endeavors and professional pursuits. This, in turn, can have significant impacts on their academic success. Besides, sometimes first-year students may not see any engineering faculty for most of their first two years of study [27][28]. During this period, students could learn the basic elements of the engineering design process by doing real design projects in the first-year engineering design course. On the other hand, previous research showed an engaging first-year engineering experience is crucial in encouraging excitement, retention, and satisfaction in engineering education [29][30]. But in many liberal arts universities, freshmen mainly focus on liberal arts subjects such as calculus, physics, chemistry, and other general education requirements, which leaves students with limited exposure to engineering. An interactive project-based engineering design course is commonly used to avoid this problem [31]. Thus, considering its importance, this study examines a freshmen engineering design course in a liberal art university to investigate teachers' and students' perceptions of sources of motivation. This two-credit course is a highly interactive seminar-style and project-based course that explores all aspects of the engineering profession, including engineering disciplines, challenges, education, and employment; creativity and design; and the professional responsibilities of engineers. The learning outcomes of this course are listed as following:

1. improve the ability to connect information from disparate contexts and perspectives.
2. improve the ability to apply engineering design concepts to solve problems in the real world.
3. improve the ability to make reflective judgment through independent and critical thinking
4. improve the ability to make and act on the moral or ethical judgment in the engineering design process
5. improve the ability to function effectively on a team.
6. improve the ability to communicate effectively with a range of audiences

This course is designed to achieve the learning outcomes listed above by assigning students design activities and projects. Table 1 shows the detailed descriptions of the teaching methods used for each learning outcome.

Table 1. Teaching methods for each learning outcome

Learning outcome (No.)	Teaching methods
1	Engineering is taught as a multidisciplinary topic that covers the different engineering majors. Through lectures, facts, videos, and open discussions, instructors present the engineering impact on humans, society, the economy, and the globe is provided in a comprehensive context that addresses the organizational structure and relation to the supply chain, financial market, and workforce. Students are exposed to facts and events in engineering that aim to raise their awareness and broaden their horizons. Also, students are required to interview an engineer to learn about his/her academic and professional perspectives.
2	Students were exposed to different applications and case studies for design challenges and constraints, where feedback was collected, and discussions occurred that discuss the design concepts and challenges. Students were provided with design reports over which they were asked to identify the design process. Also, they were required to make design decisions in some case studies using decision matrices to provide their assessment. Students were assigned an engineering design problem that requires them to build their design and apply the engineering design process on it from technical design, mockups, testing, refinement to improvement. Students develop mockup designs based on an engineering problem. Students design an experimental plan for the engineering design problem (e.g., building a floating assembly with a portable charger). Then they conducted experiments, collect and analyze data that is compared to the theoretical design. Thereafter they make conclusions and observations on the outcomes based on engineering and math concepts (e.g., Buoyancy and stability). They finally use conclusions to draw improvements to the components, system, and processes.
3	Students in every class participate in inductive learning activities that aim to mold their critical thinking and develop their technical and professional judgment. Controversial case studies from the engineering profession are presented for students, and they provide their judgment and suitable action according to the professional, technical, and ethical aspects. Students here are provided with ample wait time for students to reflect back on their responses. The instructor provides a supportive environment that respects students' opinions and encourages them to participate. The instructor uses reverse engineering and a top-down approach in explaining designs, i.e., starting with the end product and ending in components, design metrics, and evaluation. Teaching students the broader impact and the intellectual metric of engineering designs. These are all provided by a seminar-style lecture that covers wide engineering as a multidisciplinary area. The instructor conducts induvial meetings with the groups to make them aware of the requirements and challenges of teamwork and the essentials to work effectively, along with time management and proper time planning.

4	Students are given a lecture on engineering ethics, where they learn the code of ethics of various engineering organizations (ASME, ASCE, IEEE). Case studies that discuss the ethical aspect of engineering design are provided in a form of assignments (e.g., environmental, plagiarism, professional conduct).
5	During class, students are asked to formulate small groups (2-3) to conduct the class activities. These groups are assigned randomly in order to make the students meet more students and learn different perspectives. Students work in groups (3-4) on their design project that starts in the middle of the semester. Here they provide single design (interim and final) technical reports in order to increase the collaborative nature of the teams. Similarly, students work in groups to create their mockups and final designs in order to improve their teamwork.
6	At the end of the semester, students must present their designs in the form of an oral presentation in front of the whole class and instructor, where they need to properly articulate their design ideas, structures, and conclusions. Students are provided with rubrics and assessment criteria to use before a presentation. Students' presentations must show nonverbal and verbal skills (eye contact, enthusiasm, clarity, poise), subject knowledge, relevance and organization, creativity, length, and teamwork. Students also write technical reports that are a form of data dissertation to the instructor (different type of audience).

Methods

We conducted a cross-sectional survey that measured both students' and teachers' evaluations of the importance of different course goals in the freshman engineering design course.

1. Participants

We recruited a total of 50 undergraduate students from an engineering program at a medium-sized liberal arts college in the Midwest U.S. Students reported an average age of 19.26 (SD = 4.40), and most of the students were male (n = 43, 78.2%). Most students identified as White (n = 43, 86%); two students (4%) identified as Black/African American; one student (2%) identified Asian; one student (2%) identified as Latinx; one student (2%) identified as multiracial; two students (4%) identified as Middle Eastern. All but three students (94%) identified as freshmen in the program. Ten students (20%) identified as first-generation college students, and the average grade point average (GPA) of students was 3.29 (SD = 0.53). We recruited a total of five full-time faculty members who have taught the same course before from the same engineering program. Given the small sample size, we did not collect any demographic information to protect the survey responses' confidentiality.

2. Procedures

We have recruited our student participants at the beginning of the spring semester (upon completing the engineering course). Student surveys were filled out on paper in class, and then data was entered by a graduate assistant. The student's survey consisted of a series of demographic questions and his/her evaluations of how much each course objective of the engineering course motivated him/her to study hard. Teacher's responses were collected on paper, and no identifiable information was collected on the survey. Teachers were uninstructed to drop off the survey copy in a department mailbox to protect their identities. The teacher survey assessed his/her evaluations of how much each course objective of the engineering course motivated his/her students to study hard. The course objectives included this course can improve the ability to 1) connect information from disparate contexts and perspectives; 2) apply engineering design concepts to solve problems in the real world; 3) make reflective judgment through independent and critical thinking; 4) make and act on the moral or ethical judgment in the engineering design process; 5) function effectively on a team; 6) communicate effectively with a range of audiences. The level of motivation each course objective provides was evaluated on a 7-point Likert-type scale, with 1 being "very little" and 7 being "very much." Both surveys are shown in the Appendix A.

3. Analysis Plans

We first compute the descriptive statistics of each motivator among students. Then, we computed a series of paired-sample t-tests to examine whether certain course objectives motivated students more. Then, we conducted the same computations and analyses with teacher data. Lastly, we compare how these motivators rank differently between students and teachers. To further understand the relationships between demographic variables and students' motivation in this course, we computed as series of t-tests (when the demographic variable is dichotomous, e.g., sex) and bivariate correlations (when the demographic variable is ordinal, e.g., GPA). We examined the relationships between age, household income, GPA, and each motivator through a series of bivariate correlations. We examined the relationships between sex, race, being a first-generation college student, and each motivator through a series of independent-sample t-tests. Race was coded into a dichotomous variable, where being White was coded as 0, and other racial categories (i.e., racial minorities) were all coded as 1. All analyses were completed using SPSS 26.

Results

1. Descriptive Statistics

Students evaluated that being able to apply engineering design concepts to solve problems in the real world ($M = 5.88$, $SD = 1.22$) and function effectively on a team ($M = 5.79$, $SD = 1.25$) as the strongest motivators; followed by being able to make and act on the moral or ethical judgment in the engineering design process ($M = 5.33$, $SD = 1.50$), communicate effectively with a range of audiences ($M = 5.27$, $SD = 1.22$), and make reflective judgment through independent and critical thinking ($M = 5.18$, $SD = 1.42$). Students evaluated that being able to connect information from disparate contexts and perspectives ($M = 4.51$, $SD = 1.56$) as the weakest motivator.

Teachers evaluated that being able to function effectively on a team ($M = 5.60$, $SD = 0.55$) and apply engineering design concepts to solve problems in the real world ($M = 5.40$, $SD = 1.95$) as the strongest motivators; followed by being able to communicate effectively with a range of audiences (M = 4.20, SD = 1.79), make and act on the moral or ethical judgment in the engineering design process (M = 3.80, SD = 1.50), and make reflective judgment through independent and critical thinking (M = 3.40, SD = 2.07). Teachers evaluated that being able to connect information from disparate contexts and perspectives (M = 3.00, SD = 2.12) as the weakest motivator. Teachers' evaluations followed a somewhat similar pattern of students' evaluations. Although looking at the descriptive statistics, students' evaluations were numerically higher than teachers' evaluations on some evaluations. This might suggest a more conservative estimation among teachers.

2. Paired-Sample T-Tests

A series of paired-sample t-tests revealed that students evaluated being able to connect information from disparate contexts and perspectives significantly lower than all other five motivators (all $p < .01$; $-3.10 < t < -6.29$). Students evaluated being able to apply engineering design concepts to solve problems in the real world significantly higher than all motivators (all $p < .01$; $2.85 < t < 6.12$) besides being able to function effectively on a team ($t = 0.35$, $p = .73$). Students evaluated being able function effectively on a team significantly higher than all motivators (all $p < .01$; $3.12 < t < 6.29$) besides being able to apply engineering design concepts to solve problems in the real world ($t = 0.35$, $p = .73$). The full results of the paired-sample t-tests were shown in Table 1. The results confirmed that students were strongly motivated by able to apply engineering design concepts to solve problems in the real world and function effectively on a team; students were not highly motivated by being able to connect information from disparate contexts and perspectives. Given the limited sample size of teachers, we did not perform any t-test in concerns of limited statistical power and variance.

3. Independent-Sample T-Tests

First, we ran a series of independent-same t-tests on sex. The results showed female students (M = 6.33, SD = 0.82) were more motivated by being able to make and act on the moral or ethical judgment in the engineering design process ($t = 2.92$, $p < .05$) than male students (M = 5.14, SD = 1.52). Female students (M = 6.50, SD = 0.55) were more motivated by being able to function effectively on a team ($t = 2.70$, $p < .05$) than male students (M = 5.69, SD = 1.30). Female students (M = 6.17, SD = 0.75) were more motivated by being able to communicate effectively with a range of audiences ($t = 2.90$, $p < .05$) than male students (M = 5.12, SD = 1.23).

Second, we ran a series of independent-same t-tests on the binary race. The results showed racial minority students (M = 6.29, SD = 0.76) were more motivated by being able to make and act on the moral or ethical judgment in the engineering design process ($t = 3.01$, $p < .01$) than White students (M = 5.17, SD = 1.55). Racial minority students (M = 6.71, SD = 0.49) were more motivated by being able to function effectively on a team ($t = 3.97$, $p < .001$) than White students (M = 5.63, SD = 1.28).

Lastly, we ran a series of independent-same t-tests on being first-generation college students. The results showed that there were significant differences between first-generation students and non-first-generation students on all six motivators (all $p > .05$).

4. Bivariate Correlations

The bivariate correlations results showed that higher GPA was only correlated with higher evaluations of being able to make reflective judgment through independent and critical thinking ($r = .31, p < .05$). Neither age nor household income was significantly correlated with all six motivators (all $p > .05$).

Discussion

Overall, the results of this pilot study showed that teachers' evaluations followed a similar pattern to students' evaluations in the course that we evaluated. Teachers seem to have an adequate understanding of what motivated their students in the selected engineering design course. It is more likely attributed to the highly interactive teaching environment both inside and outside the classroom. A liberal art college is well-known for its small class, no matter what the major is. Several previous studies have examined the faculty's influences on a range of student outcomes such as persistence, learning, engagement, satisfaction, academic self-confidence, and educational aspirations. Most studies identified positive, significant effects of faculty contact, especially for students in the first year of college [32]. Undoubtedly, engineering educations in liberal arts colleges carry and even elevate this strength of interactions. In our case, the interactions with students are mainly reflected in the in-class activities, project guidance outside the classroom, and timely feedback and evaluations. For instance, teachers can easily observe and perceive every student's reactions and reception to a certain topic; students can easily reach out to faculty to talk about study progress or ask for feedback from various aspects.

The results also showed that students were strongly motivated by being able to apply engineering design concepts to solve problems in the real world and function effectively on a team. In this course, students were required to develop multiple engineering designs. For instance, students designed a portable phone charger by applying knowledge of electric circuits to solve the problem that people cannot charge their phone without connecting to the receptacle on the wall. This represents a form of electric circuit design that interconnects multiple components; students are also required to apply the engineering design process to design and build a functioning floating platform. Students develop mockup designs based on an engineering problem. Students design an experimental plan for the engineering design problem. Then they conducted experiments, collect and analyze data that is compared to the theoretical design. Thereafter they make conclusions and observations on the outcomes based on engineering and math concepts (e.g., Buoyancy and stability). They finally use conclusions to draw improvements to the components, system, and processes. One of the main goals of undergraduate education is to equip students with the requisite practical skills necessary for occupational success. Collaboration has always been an important aspect of professional work in engineering and is becoming an increasingly critical skill for many jobs [33]. Many studies proved that working in a team provides students with access to much different learning, working, and writing styles, thus allowing students to gain a greater understanding of collaboration [34][35]. Moreover, teamwork may also allow teachers to have more substantial interactions with students as a group. Not only is meeting with groups more productive for instructions, but it also creates a different interaction dynamic because the power structure is more diffused. More importantly, students may feel more comfortable, confident, and open with teachers in a group setting rather than in a one-on-one meeting where the teacher may dominate a discussion. In our case, students work in small collaborative groups to solve real-world problems. When students work on real-world problems, they are more motivated because real-world problems usually have proximal and tangible goals which often lead to higher self-efficacy and control among students. The pedagogy in this course achieved the goal because the real-life-based design project and related activities were implicated in personally meaningful tasks.

On the other hand, students were not highly motivated by being able to connect information from disparate contexts and make reflective judgments through critical thinking. Nowadays, engineers are required to be flexible and creative with a good understanding of human-centered design and an ability to work in multidisciplinary contexts. In school, design and other fundamental topics in engineering are often isolated in the engineering curriculum. To break down the boundaries and use the advantages of liberal arts education, engineering design was taught as a multidisciplinary topic that covered different engineering disciplines in our case. Faculty from each discipline are invited to give lectures and conduct relevant activities in class. However, the design project assigned to students is more related to a specific sub-field of engineering, which could be a potential reason why students are not motivated by this learning outcome. Students obtained substantial engineering knowledge in various areas, but still, a gap exists between multidisciplinary content and applications. Moreover, multiple faculty members from different engineering programs do not only bring diversity and expertise to the class but also can potentially cause inconsistency in teaching styles, grading, and interactions with the student. Faculty may have different mindsets in engineering and design thinking. Students may not be able to clearly captures the connections between different sub-disciplines while they were struggling to adapt to a brand-new theory system and teaching philosophy each time with a new teacher. Instructors should design the project in a way that fits the co-teaching model that also aligns with this learning outcome.

The percentage of female and racial minority students within the engineering majors accounts for a smaller portion of responses to the cross-sectional survey. The findings revealed that racial minority and female students were more motivated by being able to function effectively on a team. Female and racial minority students are the minority groups in many classes, so they constantly have to adjust to the environment around them. This could contribute to the mindset of feeling as though they have to prove their self-worth to others in their classes and on their respective teams. This could also be related to their determination to be successful within the engineering disciplines. In addition, our findings showed that female and racial minority students were more motivated by being able to make and act on moral and ethical judgment in the engineering design process. In the United States and most Western cultures, the demographics of engineering are predominated by Caucasian males. The lack of diversity in the engineering profession is considered by some to be a macro-ethical issue [36]. Although the importance of engineering ethics education is widely supported and required for program accreditation [37], it is still unclear whether students receive sufficient breadth or depth of formal education on engineering ethics [38]-[40]. For instance, many programs embed ethics education within other required courses such as a first-year or capstone design. Engineering ethics is rarely an independent and required course in the curriculum plan. Moreover, the engineering faculty who teach in higher education institutions in the United States lack a level of gender and racial/ethnic diversity equivalent to that in the American population at large [41][42]. The literature has found that diverse individuals actually bring different perspectives and experiences to the classroom [43], especially when it comes to ethics education. For example, a higher percentage of female teachers in engineering programs had more frequently given assignments that required students to discuss the ethical issues or moral implications [44]. All issues mentioned above exist in the engineering program at liberal arts college, which are potential reasons to explain why female and racial minority students were more motivated by being able to make and act on the moral and ethical judgment in this study. It is important to promote diversity in the engineering program, no matter among students or teachers.

The findings of our study should be interpreted within its limitations. First, we had a relatively small sample size of teachers from liberal arts universities. We only chose one liberal art university for the investigation. We consider this study as a pilot study for a large-scale survey research. This study focused on a single offering during a single semester. The results may lack real statistical power with the possibility that any observations are restricted to this one cohort or apply only given the delivery by this one particular teaching team. In general, the department and class size of liberal arts are much smaller than large research or comprehensive state universities. The number of teacher participants is average in an engineering program at a liberal art university. However, future research could expand on the scope of recruitment and collect a larger sample. Secondly, this study lacks validation regarding teaching methods and activities applied in this course. We did not conduct pre and post evaluation for each class activity for validation as it is not the focus of this study. This study focused on perceptions only, but future research can consider measuring specific activities. The results of this project can be used to augment applied activities and demonstrate an increase in motivation ratings in this course. Thirdly, the population of students does not have adequate diversity, although it is common in engineering programs, no matter what type of institute it is. Future research might consider expanding the investigation scope in terms of geographical locations, the complexity of the population, and analysis perspectives. The resources of motivation in this study are learning outcomes and the practice of liberal arts education. More resources and influential factors need further investigations for a more accurate and comprehensive understanding. Besides, comparing engineering students from different types of education institutes about their study motivations could help educators of liberal arts universities have a better understanding of their students and improve the engineering programs in general. Because it is a pilot, we plan to collect a more comprehensive and large-scale survey with more students in the future, rather than students in a single course.

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Appendix A: Survey Instruments

Engineering Survey Project_Students

Q1. What is your age?

____

Q2. What is your sex?

○ Male

○ Female

Q3. Which of the following best describes your race?

○ White/Caucasian

○ Black/African American

○ Asian

○ Native American

○ Latino

○ Others ____

Q4. Which of the following best describes your current standing?

○ Freshman

○ Sophomore

○ Junior

○ Senior

Q5. Which of the following best describes your current living situation?

- ◯ On-campus
- ◯ Off-campus
- ◯ With family
- ◯ Greek housing
- ◯ Others ____

Q6. Which one of the following categories best describes your household income?

- ◯ Less than $10,000
- ◯ $10,000 - $19,999
- ◯ $20,000 - $29,999
- ◯ $30,000 - $39,999
- ◯ $40,000 - $49,999
- ◯ $50,000 - $59,999
- ◯ $60,000 - $69,999
- ◯ $70,000 - $79,999
- ◯ $80,000 - $89,999
- ◯ $90,000 - $99,999
- ◯ $100,000 - $149,999
- ◯ More than $150,000

Q7. Are you a first-generation college student (i.e., nobody from your core family has ever graduated from college)?

○ Yes

○ No

Q8. What is your current approximate GPA?

____

Q9. To what extent is each factor listed below **<u>motivates</u>** you to study hard in **<u>EGE 110</u>**, on a scale from 1 to 7, 1 being "**Very Little**" and 7 being "**Very Much.**"

	Very Little 1	2	3	4	5	6	Very Much 7
EGE110 can improve the ability to connect information from disparate contexts and perspectives.	○	○	○	○	○	○	○
EGE110 can improve the ability to apply engineering design concepts to solve problems in the real world.	○	○	○	○	○	○	○
EGE110 can improve the ability to make reflective judgment through independent and critical thinking	○	○	○	○	○	○	○
EGE110 can improve the ability to make and act on the moral or ethical judgment in the engineering design process.	○	○	○	○	○	○	○
EGE110 can improve the ability to function effectively on a team.	○	○	○	○	○	○	○
EGE110 can improve the ability to communicate effectively with a range of audiences.	○	○	○	○	○	○	○

Q10. To what extent is each factor listed below **motivates** you to study hard in **in the engineering program**, on a scale from 1 to 7, 1 being "**Very Little**" and 7 being "**Very Much.**

	Very Little 1	2	3	4	5	6	Very Much 7
Interactions with teachers inside the classroom.	○	○	○	○	○	○	○
Interactions with teachers outside the classroom.	○	○	○	○	○	○	○
Interactions with peers inside the classroom.	○	○	○	○	○	○	○
Interactions with peers outside the classroom.	○	○	○	○	○	○	○
The efficiency and speed of feedback from teachers.	○	○	○	○	○	○	○
The quality of content in teaching.	○	○	○	○	○	○	○
The performance of the teacher during lectures.	○	○	○	○	○	○	○
Having confidence in learning the concepts taught in course.	○	○	○	○	○	○	○
Fear of a bad grade.	○	○	○	○	○	○	○
The desire to please others including teachers, parents, and friends.	○	○	○	○	○	○	○
The desire to be a good student.	○	○	○	○	○	○	○
My competitive nature.	○	○	○	○	○	○	○
Curiosity about the subject.	○	○	○	○	○	○	○

Q11**.** To what extent is each group of people listed below **<u>motivates</u>** you to study hard **in the engineering program**, on a scale from 1 to 7, 1 being "**Very Little**" and 7 being "**Very Much**."

	Very Little 1	2	3	4	5	6	Very Much 7
Teacher(s)	○	○	○	○	○	○	○
Academic advisor	○	○	○	○	○	○	○
Department administrator	○	○	○	○	○	○	○
Parents	○	○	○	○	○	○	○
Sibling(s)	○	○	○	○	○	○	○
Romantic partner	○	○	○	○	○	○	○
Peers/classmates	○	○	○	○	○	○	○
Friends	○	○	○	○	○	○	○

Q12. To what extent is each factor listed below discourages you from studying hard **in the engineering program**, on a scale from 1 to 7, 1 being "**Very Little**" and 7 being "**Very Much**."

	Very Little 1	2	3	4	5	6	Very Much 7
Lack of pre-requisite skills needed for this program.	○	○	○	○	○	○	○
Lack of self-discipline.	○	○	○	○	○	○	○
Feeling indifferent about my performance in this program.	○	○	○	○	○	○	○
Lack of care about the performance.	○	○	○	○	○	○	○
Fear of numbers, math, and/or statistics.	○	○	○	○	○	○	○
The subject is boring.	○	○	○	○	○	○	○
The courses are too challenging.	○	○	○	○	○	○	○
Negative influences of other people.	○	○	○	○	○	○	○

Engineering Survey Project_Teachers

Q1. What is your age?____

Q2. To what extent is each factor listed below **motivates** your students to study hard in **EGE 110 and/or EGE 120**, on a scale from 1 to 7, 1 being "**Very Little**" and 7 being "**Very Much.**"

	Very Little 1	2	3	4	5	6	Very Much 7
EGE110 can improve the ability to connect information from disparate contexts and perspectives.	○	○	○	○	○	○	○
EGE110 can improve the ability to apply engineering design concepts to solve problems in the real world.	○	○	○	○	○	○	○
EGE110 can improve the ability to make reflective judgment through independent and critical thinking	○	○	○	○	○	○	○
EGE110 can improve the ability to make and act on the moral or ethical judgment in the engineering design process.	○	○	○	○	○	○	○
EGE110 can improve the ability to function effectively on a team.	○	○	○	○	○	○	○
EGE110 can improve the ability to communicate effectively with a range of audiences.	○	○	○	○	○	○	○

Q3. To what extent is each factor listed below **motivates** your students to study hard in **in the engineering program**, on a scale from 1 to 7, 1 being "**Very Little**" and 7 being "**Very Much"**

	Very Little 1	2	3	4	5	6	Very Much 7
Interactions with teachers inside the classroom.	○	○	○	○	○	○	○
Interactions with teachers outside the classroom.	○	○	○	○	○	○	○
Interactions with peers inside the classroom.	○	○	○	○	○	○	○
Interactions with peers outside the classroom.	○	○	○	○	○	○	○
The efficiency and speed of feedback from teachers.	○	○	○	○	○	○	○
The quality of content in teaching.	○	○	○	○	○	○	○
The performance of the teacher during lectures.	○	○	○	○	○	○	○
Having confidence in learning the concepts taught in course.	○	○	○	○	○	○	○
Fear of a bad grade.	○	○	○	○	○	○	○
The desire to please others including teachers, parents, and friends.	○	○	○	○	○	○	○
The desire to be a good student.	○	○	○	○	○	○	○
My competitive nature.	○	○	○	○	○	○	○
Curiosity about the subject.	○	○	○	○	○	○	○

Encouragement from others, including teachers, family, and friends.	○	○	○	○	○	○	○

Q4 .To what extent is each group of people listed below **<u>motivates</u>** your students to study hard **in the engineering program**, on a scale from 1 to 7, 1 being "Very Little" and 7 being "Very Much."

	Very Little 1	2	3	4	5	6	Very Much 7
Teacher(s)	○	○	○	○	○	○	○
Academic advisor	○	○	○	○	○	○	○
Department administrator	○	○	○	○	○	○	○
Parents	○	○	○	○	○	○	○
Sibling(s)	○	○	○	○	○	○	○
Romantic partner	○	○	○	○	○	○	○
Peers/classmates	○	○	○	○	○	○	○
Friends	○	○	○	○	○	○	○

Q5. To what extent is each factor listed below **<u>discourages</u>** your student from studying hard in **the engineering program**, on a scale from 1 to 7, 1 being "**Very Little**" and 7 being "**Very Much.**"

	Very Little 1	2	3	4	5	6	Very Much 7
Lack of pre-requisite skills needed for this program.	○	○	○	○	○	○	○
Lack of self-discipline.	○	○	○	○	○	○	○
Feeling indifferent about my performance in this program.	○	○	○	○	○	○	○
Lack of care about the performance.	○	○	○	○	○	○	○
Fear of numbers, math, and/or statistics.	○	○	○	○	○	○	○
The subject is boring.	○	○	○	○	○	○	○
The courses are too challenging.	○	○	○	○	○	○	○
Negative influences of other people.	○	○	○	○	○	○	○