What Can DISC and Motivation Profiles Disclose About Student Retention in Engineering?

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Abstract

In 2015 the engineering departments at the University of Denver (DU) partnered with the Indigo Project to perform an assessment of the freshman engineering students using DISC and Motivation profiles. These profiles are a part of the overall Indigo Assessment, which helps educators observe the non-academic traits of their students. The multi-dimensional, four-science survey also measures development in 23 soft skills and social emotional perceptions. DISC comprises four behaviors: Dominance, Influencing, Steadiness, and Compliance. The six Indigo Assessment Motivators are Theoretical, Utilitarian, Aesthetic, Social, Individualistic and Traditional. Some observations from the 2015 data include indications that the program attracts and develops high potential entrepreneurs, that these engineering students are particularly high Theoreticals (passion for learning), and are generally well-rounded and varied in terms of behavior styles and motivations. In 2017, the same set of students (now seniors) has been re-assessed as part of the ongoing DU and Indigo partnership.

Comparing these data sets, along with information about how the class make-up changed over three years, our paper will analyze which of the initial students stayed in engineering at DU, which left engineering, which left DU, and how the students changed between their freshman and senior years. The goal of the study is to see if there is any information in the students' non-academic profiles that can help determine why a student may have succeeded in engineering at DU or decided to leave. A future objective will also address the possibility of using the profiles of students to help move towards personalized learning in order to aid in retention of students within the program.

Introduction

Since the 1980s interest in engineering, along with other technical careers, has been on the decline. For this reason, there is much interest in increasing retention in engineering programs, as it is more efficient to maintain a student who shows interest in engineering rather than recruit a new student from high school. On average, retention of non-minority students is around two-thirds, while the retention of minority students is especially difficult as only one-third of minority students who start in engineering programs complete their engineering degree [1].

While retention of engineering students has been linked to different factors over the past few decades [2], at the University of Denver (DU) there was an interest in observing the effect of non-academic indicators that focused on softer skills. Previous studies had documented engineering student success in terms of personality type by using personality profiles, specifically the Myers-Briggs Type Indicator [3,4]. Within the Ritchie School of Engineering and Computer Science at DU, it was desirable to use personality profiles to observe whether there were differences in non-academic traits found between the group of

students who stayed in the engineering program, and those who did not, whether because of a change of major or leaving the university. The long-term goal is to be able to use this information to move towards personalized learning in order to focus on the specific personalities and motivations of the students.

Because it was desirable to look beyond just personality, it was decided to use an assessment of personality and motivational factors. Specifically this was done using the Indigo Assessment, which looks at DISC profiles as well as six different motivators and indicators of soft skills and social-emotional health. DISC profiles have been used by other studies to observe the learning personalities of students, both as individuals and for group settings [5,6]. However, DISC profiles combined with the other above factors have not been used to observe retention before, which is the goal of this study. Additionally, this study looked at changes in the personality profiles of students that stayed in the engineering program from freshman to senior year.

Methods

The Indigo Assessment was used to observe the personality profiles and motivators for a cohort of engineering students during their freshman and senior years. The assessment was first given to 91 students (72 male and 19 female) enrolled in a first year engineering course during the spring quarter of their freshman year in 2015. The same assessment was given to all of the students enrolled in senior design during the fall quarter of 2017. There were 46 total students (36 male and 10 female) who took the assessment both as freshmen and seniors. Of the 45 students who did not take the survey as seniors, 15 students (11 male and 4 female) stayed at DU, but changed majors and 22 students (18 male and 4 female) were no longer enrolled at DU in the fall quarter of 2017. The remaining 8 students either did not take the survey or had already graduated (6 male and 2 female).

At its most basic level, the Indigo Assessment helps give voice to those things that we all know but are challenged to find words to express about ourselves. There is nothing in the tools that can be classified as good or bad. The tools help articulate how each person is unique and helps identify different strengths and weaknesses, which can be worked on and altered.

Indigo developed its assessment platform specifically for education, working with its technology partner, TTI Success Insights. TTI has a 30+ year record providing research-based, validated assessment and coaching tools for use with working adults.

The Indigo Assessment is an online instrument that takes approximately 30 to 45 minutes to complete. Students accessed the survey online, and were instructed that staying mentally on task was crucial and that it was important to complete the entire survey without interruption. It was emphasized that there are no right or wrong answers and to not overthink replies.

The four-part tool assesses behavioral style, motivators, competencies, and social-emotional well-being. The first assessment (DISC) measures normal behavior or how a

person carries out decisions and how they want to receive communication that influences them. The second assessment looks at motivators, or the "why" behind a person's actions. The third assessment is the Personal Soft Skills Indicator (PSSI), which measures 23 skills considered to be important components of adult competency. The fourth assessment measures perceptions (external and internal) that are strong indicators of social-emotional health; it is based on the HVP (Hartman Value Profile). Validity and reliability of the instruments are well-established [7]. In this paper, we will focus on the behavioral (DISC), motivational, and skills (PSSI) aspects of the assessment.

Results and Discussion

While the initial goal of comparing the assessments from freshman versus senior year was to consider retention, there were other areas of interest such as the changes that occurred in the students who stayed in the program from freshman to senior year, including an observation of female versus male students. It is important to note that the numbers used for comparison represent a small group of students, and while trends can be observed, the statistical significance was not calculated. The results of the different comparison groups are given and discussed below:

Students who stayed in the engineering program versus those who stayed at DU, but changed majors

Of the initial group of 91 who took the survey, there were 15 who stayed at DU, but changed to a different major outside of the engineering departments. Of these students seven switched to natural science and math, five switched to computer science, two switched to business, and one to history.

When observing the DISC profiles, it was decided to compare the groups based on gender. Figure 1 shows a comparison of the DISC scores for female students who stayed in the program versus those who changed majors.

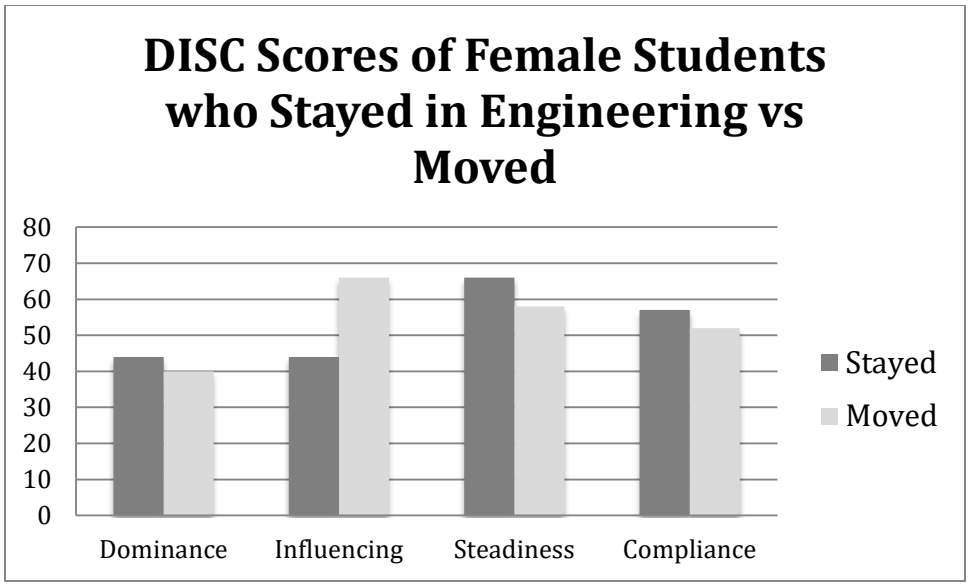

FIGURE 1: DISC scores of female freshman students comparing those who remained in the program through senior year and those who switched to different majors within the university. Influencing among females who stayed (n=11) was mean 45.2 +/- 9.2. Influencing among females who moved (n=4) was mean 66.0 +/- 13.2.

As shown in Figure 1, the female students who stayed in the program had higher scores in Dominance, Steadiness, and Compliance. The female students who left the program had a markedly higher score in Influencing. This higher Influencing score is usually an indicator of more talkative, people-oriented personalities. Interestingly, of the female students who remained in the program as seniors 0% had any increase in their Influencing score, and the overall average decreased. This indicates that the engineering program may dissuade female students with people-oriented personalities and that it may also lead to a decrease in this personality trait over time. Because women are an underrepresented demographic in almost every engineering program, it is desirable to find ways to retain female students who would be successful. This data indicates that it may be possible to highlight female students who have a personality that does not fit our traditional program profile, but may be supported with this personality in mind in order to retain them as students. Once these students are identified, it would be beneficial to develop mentoring and programming to help motivate them to continue in engineering.

Figure 2 shows the DISC behaviors of the male students who stayed in engineering versus those who switched to other majors.

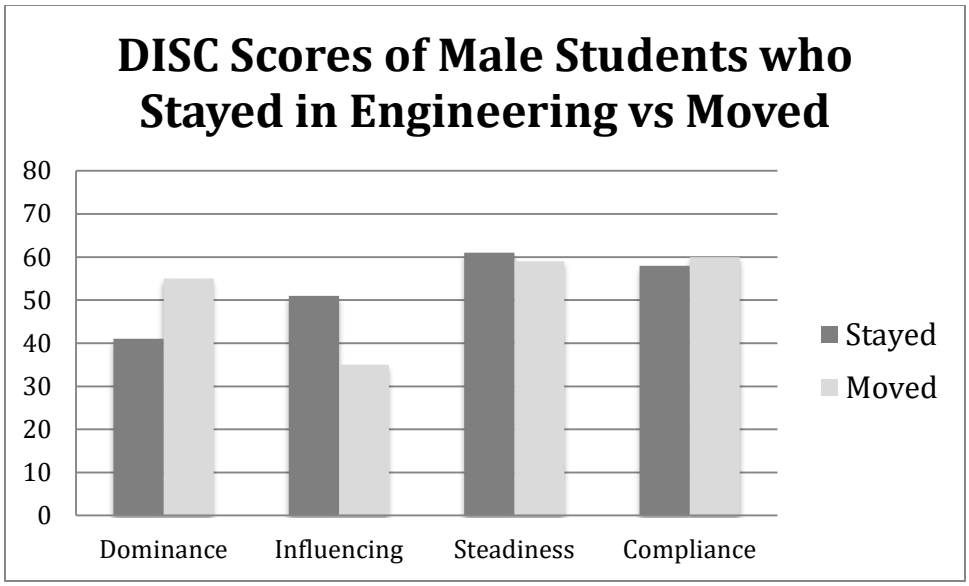

FIGURE 2: DISC scores of male freshman students comparing those who remained in the program through senior year and those who switched to different majors within the university. Dominance among males who stayed (n=41) was mean 39.1 +/- 3.2 while dominance among males who moved (11) was mean 55.5 +/- 8.1. Influencing among males who stayed was mean 51.1 +/- 4.1 while influencing among males who moved was 34.7 +/- 7.1.

For this comparison group it was observed that those who left the program had higher scores in Dominance and lower scores in Influencing, this was opposite of their female counterparts. The scores for Compliance and Steadiness were very close for male students between both groups. While the male students who stayed in the program showed an overall increase in Dominance by senior year, it did not reach the level of the male students who left the program. Traditionally engineering students tend to have lower Dominance scores, therefore it follows that Ultra-High Dominance students may leave the program. Like the female students highlighted above, there are some male students who could be successful in the engineering program, however their personality does not match with that of the current student. It may be possible to identify these Ultra-High Dominance students and give them unique opportunities that work with this personality trait, instead of against it. An example of this could be something in the field of entrepreneurship, an area where high dominance is praised and which is also very valuable within an engineering program.

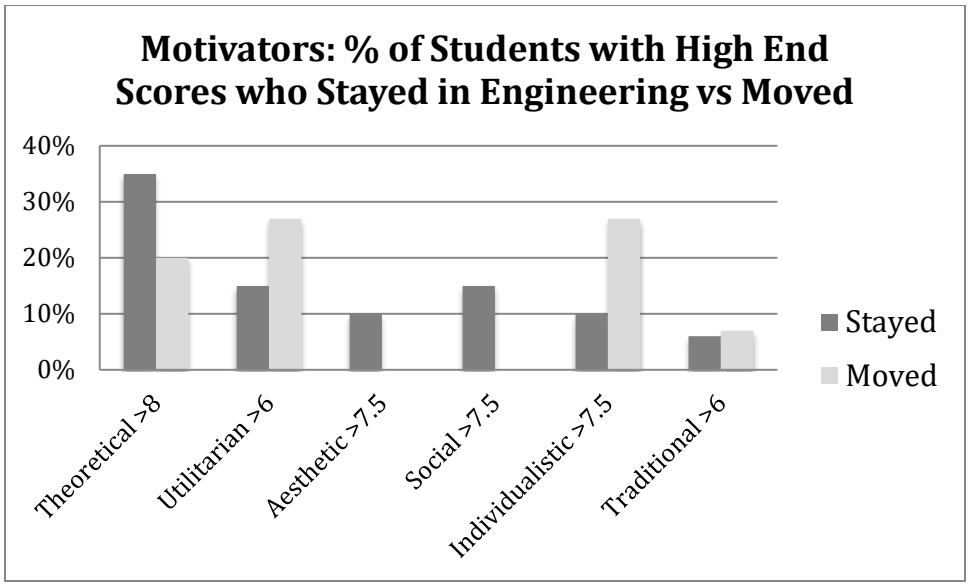

FIGURE 3: Comparison of the percentage of freshman students who had high end motivator scores in different areas based on whether they stayed in the engineering program versus changed to a different major within the university.

The motivators of the students who stayed in engineering versus those who changed majors are shown above in Figure 3. The highest motivator for the students who stayed in engineering was Theoretical, while the students who left the program were more motivated by Utilitarian and Individualistic reasons, which are related to results for efforts and control and recognition, respectively. It is also of note that none of the students who changed majors were highly motivated by Social or Aesthetic reasons. Overall it is unlikely that students with low Theoretical motivator scores would stay in an engineering program. However, if a student shows enough Theoretical motivation, but varies in other areas, it may be possible to use personalized learning tools to help with retention.

In general, the Indigo Assessment provided insight into the personality profile differences between those students who stayed in the program versus those who stayed at the university, but changed majors. These differences can provide important, and actionable, clues regarding which students are less well-aligned with (and can help serve as change agents for) the existing culture, and should be intentionally flagged for additional support and attention.

Students who stayed in the engineering program versus those who left DU:

There were 22 students who took the survey as freshmen and were no longer at DU in Fall 2017. There is not any available information on why the students left DU, therefore it cannot be said whether they left college all together, transferred to a different engineering program, or transferred elsewhere and changed majors. However, there were still noticeable trends among these students compared to those who stayed in engineering. They showed high motivation in Utilitarian, Social, and Traditional, while had a lower Theoretical score.

Changes in students who stayed in the engineering program from freshman to senior year:

Forty-six of the students who remained in the engineering program completed the same Indigo Assessment at the beginning of their senior year. It was of interest to see how the personality profiles, motivators, and skills changed over the two and half years between assessments. When comparing the DISC profiles between freshman and senior years, there were slight changes in each category, as shown in Figure 4.

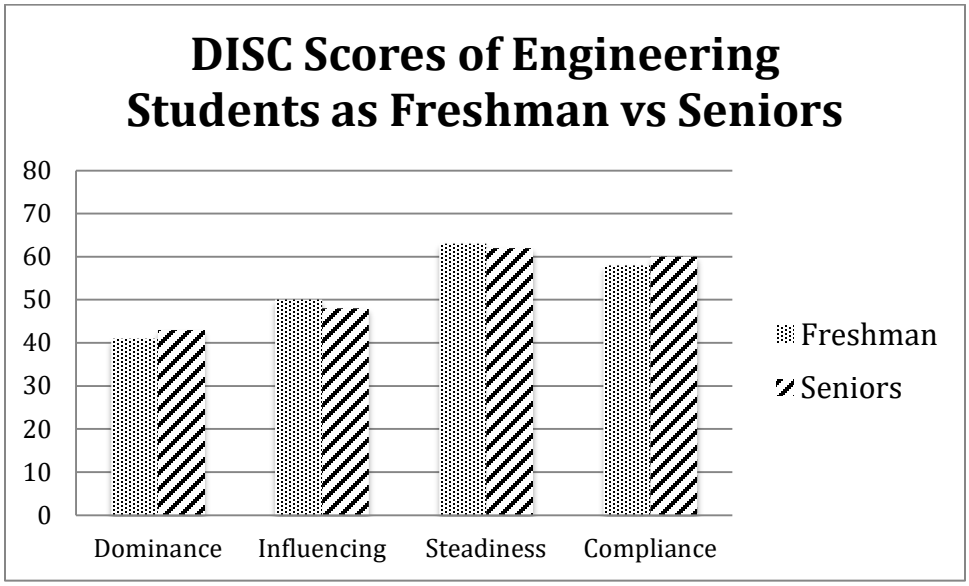

Figure 4: DISC scores of the students who stayed in the engineering program as freshman (spring 2015) versus seniors (fall 2017).

However, when the data was split between genders, changes were more apparent. As shown in Figure 5, the female students had a decrease in Dominance and Influencing, with 0% of female students showing any increase in either category. The female students also showed an increase in both Steadiness and Compliance with 0% of female students showing any decrease in either category.

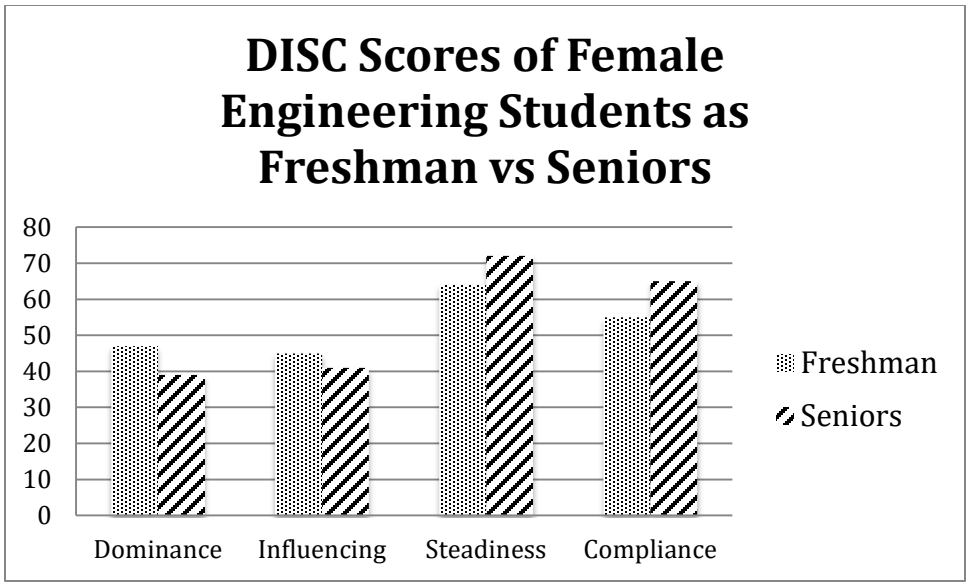

Figure 5: DISC scores of the female students who stayed in the engineering program as freshmen (spring 2015) versus seniors (fall 2017).

In comparison, Figure 6, shows that the male students had an overall increase in Dominance and decrease in Steadiness.

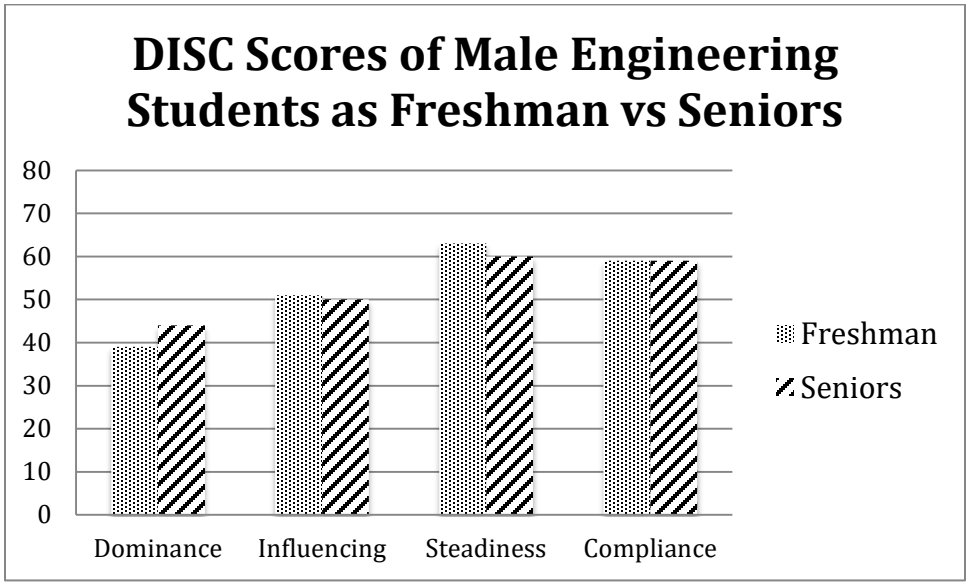

Figure 6: DISC scores of the male students who stayed in the engineering program as freshman (spring 2015) versus seniors (fall 2017).

Along with a variance in their DISC profiles, the men and women also had different motivators as seniors. As shown in figure 7 the female students had higher scores for Theoretical, Social, and Aesthetic motivators, while the male students had higher scores for Individualistic and Utilitarian motivators. These types of female-to-male differences can drive real disconnects and differing expectations that may be especially challenging for the minority (22%) who are female.

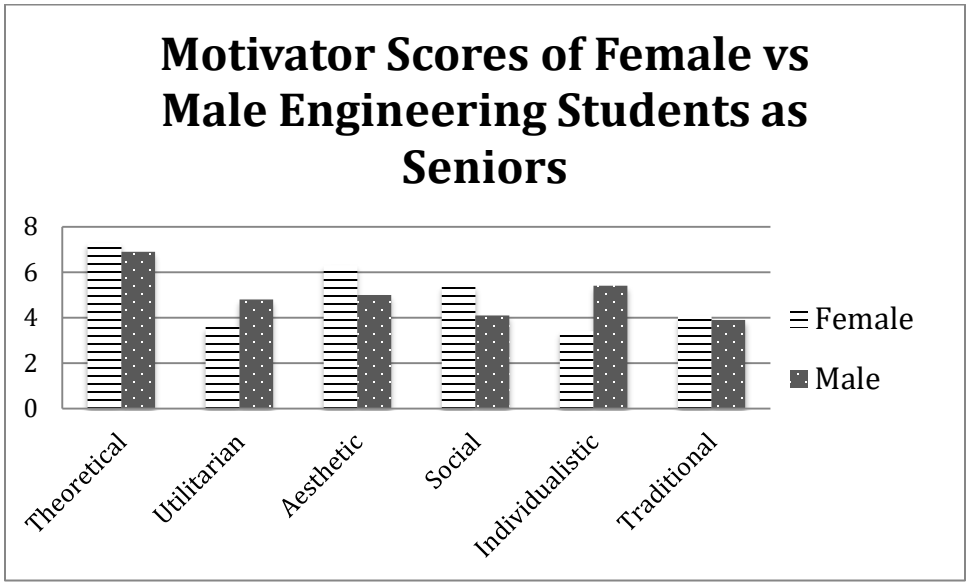

Figure 7: The motivator scores of the engineering students as seniors, comparing the male versus female students.

Another area where gender showed differences was the change in skills reported by the students between freshman and senior year. As shown in table 1 there was some change in each skill for both genders, however the women had much greater variance between freshman and senior year. The male students did not have any area that changed more than 10%, while the women had several. They had a greater than 10% decrease in Decision Making, Flexibility, Futuristic Thinking, Goal Orientation, Interpersonal Skills, Leadership, Persuasion and Presenting. The two areas they had a greater than 10% increase were Diplomacy Tact and Planning Organizing.

Table 1: The percentage change in soft skills between freshman and senior year of the female and male engineering students.

Skills	% Change Female	% Change Male	Skills	% Change Female	% Change Male
Analytical Problem Solving	-3.8	-2.0	Futuristic Thinking	-11.4	7.1
Conflict Management	-4.5	-2.1	Goal Orientation	-13.3	-1.5
Continuous Learning	-5.7	2.8	Interpersonal Skills	-12.6	2.9
Creativity Innovation	-3.0	9.8	Leadership	-18.3	4.5
People Advocacy	0.4	3.8	Management	2.3	3.8
Decision Making	-10.7	4.9	Negotiation	1.5	3.5

Diplomacy Tact	13.7	6.3	Personal Responsibility	-6.6	-0.1
Empathy	-4.7	-4.4	Persuasion	-18.7	-3.0
Mentoring Coaching	5.7	2.8	Planning Organizing	13.0	-0.4
Flexibility	-14.3	-1.5	Presenting	-14.6	7.6
Time Priority Management	-9.9	-5.0	Written Communication	-1.9	2.3
Teamwork	-8.4	1.1			

The assessment measures skills competencies as reported by students (indicating their level of comfort and confidence in a given skill). Small sample sizes (10 women and 36 men in the longitudinal group) lead us to take as much note of directional differences between the groups as absolute changes. We observed that the skills gap widened (men grew and women declined) in Creativity Innovation, Decision Making, Futuristic Thinking, Leadership, and Presenting and the skills gap widened (women grew and men declined) in Planning Organizing.

Overall the female students underwent greater changes than their male counterparts between freshman and senior year. Because female students represent the gender minority, it is possible that the changes were due to pressures felt by the women to shift their behaviors in order to fit in with the majority. Future goals include interviewing female students across the program to acquire more detailed information on their perspective during their time in the engineering program.

Individual Case Studies

While the above data give a good snapshot of the entire engineering class, it is also advantageous to look at individual case studies. These allow for observations of the changes within a specific student and could help with advising and/or career guidance.

The first is a male student who, as a freshman, had an ultra-high individualist score with a high influencing score. When the student retook the survey as a senior he showed an increase from low to high dominance, his utilitarian motivator was off the charts, and he showed a strong development in his management and planning/organizing skills. Along with this he went from not being among the students listed as potential "Entrepreneurs" to being number two on said list. These changes are interesting when it was noted that this student was part of a student run start-up company which developed a new app and participated in a national business model competition. There is a strong chance that this student's experience affected his motivational profile and also improved his skills in related areas. This example highlights the importance of giving students new opportunities to help them discover their passions within the engineering field.

A second case study involves a female student who came in with ultra high dominance and compliance scores, as well as an ultra high theoretical motivation score. As shown above, on average the female students showed decreases in their dominance and influencing scores. This student, however, had a steady dominance and influence score from freshman to senior year and across the board had a very stable profile. This is of interest because this student's personality appeared "bulletproof" even when many of her female peers appeared to adjust their personalities to work with their majority male colleagues. This student is also one of the highest academic achievers in the class and has already been accepted to multiple PhD programs in engineering. This example shows that not all female students can be grouped into the average, and that individual considerations are important when thinking about how to advise and motivate students.

Conclusions:

There were identifiable differences between the Indigo Assessment profiles of students (including between female and male students) who stayed in the engineering program, who changed majors, and who dropped out. These differences offer significant information about specific students, providing insight into actions that can be taken to help motivate and support said students, which may increase overall student retention.

An unexpected finding in this assessment was the evolution observed among female students, as distinct from males, during their time in the program. The behavioral changes (decreased Dominance and Influencing, increased Steadiness and Compliance), motivator differences, and greater skills changes observed among the women have prompted us to further investigate environmental factors in our program that, if addressed, could help increase our retention and success rate with female engineering students.

Educators' perspective on teaching students as individuals (not as hypothetical "average" learners) is rapidly developing in the field, as is the body of strategies and interventions that have been found to aid in individualized approaches. Being armed with better insights on "who" our students are helps better prepare us for our future objective, that being to address the possibility of using the profiles of students to help move towards personalized learning in order to aid in the retention - as well as success - of students within the DU Engineering program.

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