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Engineering Students' Self-Concept Differentiation: Investigation of Identity, Personality, and Authenticity with Implications for Program Retention

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Abstract

Despite many efforts, women continue to be underrepresented in engineering. Herein, we seek to contribute to the body of knowledge impacting female engineering student retention challenges. Our theoretical lens is identity theory and self-concept differentiation. More specifically, we used an exploratory approach to assessing freshmen and senior engineering students' personality across engineering and non-engineering contexts. First, we wanted to find personality profiles among engineering freshmen and seniors in engineering settings, and then compare them to their personality in nonacademic settings and authenticity between the two. Personality and authenticity methods, of which were the Big 5 and Authenticity scale, were used in a survey to determine personalities of participants between academic level and gender in their engineering and nonacademic environments. From collecting and analyzing the data, results show that engineering students mainly described themselves as agreeable (i.e. helpful, trusting, considerate), conscientious (i.e. thorough, reliable, follows through with plans), open to experience (i.e. curious, inventive, deep thinker). We also found that female engineering students showed a significant difference in extraversion factors between the freshman and senior classes, and senior females show the greatest personality and authenticity variation between environments. Further exploring engineering identity, personality, and authenticity will develop a better understanding of engineering students of how they perceive themselves in and out of engineering contexts.

Introduction

Despite many efforts and programs to increase the representation of female students in engineering, a persisting low percentage of 18-20% of engineering students are women and only 14% of U.S. engineers are women[1]. The recruitment rates of women engineering students are higher than retention rates, suggesting a fallout of female engineering students throughout their years studying engineering. The current percentage of women in the United States with bachelor degrees in engineering is 19.2% [2, 3]. This percentage is a slight 0.8% increase from 2010, when the percentage of women with bachelor degrees in engineering was 18.4% [3].

An area of research that has received attention over the years to help contribute to our understanding of why we lose women in engineering is identity. ***Identity is thought to be a set of meanings that are applied to the self in different social roles or situations that serve as a defining reference of one's self*** [4]. Further, strong identification with a group has been linked to reduced likelihood of group desertion[5], as well as organizational commitment[6]. An identity consists of both social and personal identity[7]. In this society, stereotypes lead women to feel incompatible to engineering and other STEM fields[8]. Women that clash individual and career identities are often forced to choose whether to stick to their own personal identity, or to sacrifice their personal identity in order to identify with engineering[9]. An engineering identity does not come with a formula for success; however, some factors do relate to forming an engineering identity, including professional persistence[10]. Promoting qualities of engineering that correspond

to women's engineering identity could increase the likelihood that they believe engineering does fit their personality, and therefore persist in the field[11].

Accompanying studies of engineering and engineer identity, **self-concept differentiation (SCD)** is another important construct for understanding all students in engineering, particularly those that are underrepresented, like women. ***SCD occurs when individuals perceive themselves as having different personality characteristics across diverse roles and resulting to a sense of disharmony in the self-concept***[12]. For example, an individual may feel much more extraverted in their home setting than they do their work setting. SCD has been positively linked to indices of maladjustment, depression, and anxiety[12, 13]. Thus, insights into understanding engineering students' SCD becomes critical in being able to improve recruitment and retention efforts.

In SCD theory, personality plays a key role. ***Personality refers to individual differences in characteristic patterns of thinking, feeling and behaving***. The model used for this study is the Big Five personality factor model, which has been well established in explaining individual differences across the five factors of Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience[14]. The model acts as the most-used psychological tool, offering a variety of dimensions of personality to measure individuals[14, 15]. The Big Five framework is also the most researched personality model and is supported as a valid measurement tool[15]. Studies have used the Big Five theory as a tool to measure parameters such as job satisfaction, authenticity, subjective well-being, and narrative identity[16, 17, 18]. We use the Big Five model in this study to measure students' personalities in their engineering and non-engineering environments.

Because people do behave differently in different roles and situations[19], when studying personality, it also becomes critical to study cross-situational or cross-role variability[18]. This again points back to SCD theory. Authenticity of personality now becomes another critical facet to understanding identity and SCD. ***Authenticity is the way one's behavior represents their authentic self, an "internally caused" phemonemon***[18]. Sheldon et al. states that individuals' self-expression and choice can significantly influence their authenticity[18]. In Big Five terms, neuroticism or extraversion can be relatable to authenticity through their similar quality of well-being[20]. It is most comparable to traits like "truthfulness", "positive values", and "sincerity", though, and results in integration and organization[20, 18]. Just like not all roles allow for the same personality, not all roles allow for authentic behavior[18]. However, variation away from authenticity is more alarming than variation in personality or lack of consistency[18]. We use authenticity in this study for the purpose of better understanding participants' personal stance on themselves in their engineering and non-engineering environments.

Herein, we see that identity, self concept differentiation, personality, and authenticity are interrelated. The purpose of this study is to investigate cross-group differences (male vs female) among freshmen and senior engineering students in order to better understand how engineering students perceive their personality and authenticity across engineering and non-engineering contexts. The research questions guiding this effort are:

(1) What personality profiles are engineering students displaying as freshmen and seniors in engineering environments?

(2) What variations in personality profiles and authenticity are present among engineering students' different roles in engineering and non-engineering environments?

Methodology

Quantitative methods and cross-sectional research are used to complete this study. Quantitative data was collected in the form of an online survey (via Qualtrics), a version of which was first developed and implemented by Casto et al.[11]. The survey used for this study consisted of question topics ranging from identity and personality to authenticity and persistence. The Big Five Personality model was the main framework used to measure personality. More specifically, students were asked to reflect on their personality during two different contexts or situations - "non-academic settings" and "engineering academic settings".

The adjective checklist approach was used in the development of the survey, previously generated and used by Casto et al., **Table 1**[11]. This approach uses personality traits, words, or phrases for self-description and is stated to be simple and be high in face validity[11]. The Personality Adjectives Check List and methods of Strack[21] were followed by Casto et al.[11] to generate a number of words and phrases that would describe a person. The list was then narrowed by removing sensory words and phrases, as well as examinations pertaining to "fundamental identity characteristics"[11].

Table 1: A list of all adjectives on the checklist for each corresponding personality factor (table borrowed from Casto et al.)[11]

Personality Factor	**Description and Definition** (Costa & McCrae, 1992)	**List of Corresponding Adjectives** (*Note*: R = reverse coded adjective)
Agreeableness	The tendency to be trusting, sympathetic, cooperative, and move toward rather than away from others.	compassionate, cooperative, individualistic, honest, optimistic, rude-R, agreeable, considerate, sympathetic, selfish-R, helpful, and stubborn-R
Conscientiousness	The tendency to be well-organized, diligent, self-controlled, and directed in actions.	ambitious, analytical, determined, efficient, lazy-R, meticulous, organized, precise, realistic, self-disciplined, studious, and systematic
Extroversion	The tendency to be social, active, interact with others, and experience positive emotions.	assertive, domineering, reserved-R, sociable, extroverted, adventurous, timid-R, energetic, passive, talkative, withdrawn-R, introverted-R
Neuroticism	The tendency to experience distress and emotional instability. A propensity to experience negative emotional states.	confident-R, emotional, envious, fragile, resilient-R, argumentative, impulsive, anxious, high-strung, unemotional-R, irritable, and stable-R

Openness to Experience	The tendency to be imaginative, open minded, sensitive to aesthetics, and have broad interests.	artistic, creative, curious, imaginative, inquisitive, intellectual, inventive, traditional-R, unique, industrious, simple-R, shallow-R

The survey consists of two sets of 44 items corresponding to the Big 5 categories, in which from a 1-5 scale (1 being "strongly disagree" and 5 being "strongly agree"). The Big 5 personality factors are displayed in Table 1 with corresponding adjectives. Along with the Big 5 items in each environment, authenticity in these environments is measured using Sheldon's Authenticity Scale[18]. There are five authenticity-related questions for each environment with a 1-9 scale (1 being strongly disagree and 9 being strongly agree).

The authenticity questions used in Sheldon's work were validated using the authenticity scale, which consists of three subscales: authentic living, accepting external influence, and self-alienation[18, 20, 22]. Four questions are associated with each of the three subscales to make up the authenticity scale, yet to condense the survey, the questions Sheldon were used[18].

The justification for the authenticity survey items is found in Sheldon's article on "trait self" versus "true self" as well as Casto et al[18, 11]. Sheldon's survey methods are similarly represented in this current study. The personality items were chosen and validated to represent the Big 5 traits. Part of the survey given was from previous identity research completed by Pierrakos and Casto, copyrighted 2011[11].

Sample Population

Participants for this study were freshman and senior engineering students at James Madison University. All students were identified through a class list provided by the department. The survey was administered to a total of 102 senior engineering students and 165 freshman engineering students, adding up to a total of 267 students. The data received was anonymous to protect the identity of the students who participated. An incentive, dining voucher to be used at campus dining facilities, was provided to participants for completing the survey entirely. Participants selected an identifiable 4-digit code, which was used to determine survey completion and also used by a person external to the research team to hand off dining vouchers. Although 81 freshman students started the survey, only 41 students finished the survey. In terms of gender, 29 male freshmen completed the survey and 12 female freshmen completed it. While 55 senior students started the survey, also 41 students completed it, consisting of 27 male and 14 female. The response rates for the freshman and seniors were respectively 25% and 40%.

Data Analysis

Deriving descriptive statistics was the major means of data analysis in this study. Tables and charts are presented to allow for comparing female students to male students, as well as freshman to senior students. Quantifiable information and analysis allows for the discovery of personality differences across groups.

Results and Discussion

All results are presented with the frequently endorsed adjectives (FEAs) regarding the Big 5 categories. The items were determined an FEA when 65% or more of the population endorsed them, as used in Casto et al[11]. The research questions are given below with associated results, given in forms of tables and charts for freshmen and senior engineering students. Other graphs differentiate between freshman female and senior female, as well as cross group differences between male and female.

RQ1: What personality profiles are engineering students displaying as freshmen and seniors in engineering environments?

Personality items relating to the Big 5 categories were rated by the participants to describe themselves in engineering environments. Participants selected the items/adjectives there were descriptive of themselves in general in engineering academic contexts. **Table 2** shows the participants' Frequently Endorsed Adjectives (FEAs) and the corresponding percentage of students endorsing each item/adjective. These *self* FEAs are organized up by gender and class level, as shown below (senior female, senior male, freshman female, freshman male). The Big 5 Factor is located on the left side column of each participant group. The number of FEAs for each Big 5 category is also displayed in **Figure 1** for each participant group. Both Table 2 and Figure 1 reveal that the majority of engineering students described themselves using Big 5 factors of agreeableness, conscientiousness, and openness. More specifically, *freshman females* predominantly described themselves as agreeable (i.e. considerate and kind to almost everyone, helpful and unselfish with others, trusting, cooperative), conscientious (i.e. reliable, thorough, persevering), extraverted (i.e. talkative, full of energy, assertive personality), and displaying openness (i.e. active imagination, curious, inventive, reflective). *Freshman males* has a similar profile to the freshman females (i.e. agreeable, conscientious, and displaying openness), but not describing themselves as extraverted. *Senior females* predominantly described themselves as agreeable (i.e. helpful, trusting, considerate), conscientious (i.e. thorough, reliable, follows through with plans), and displaying openness (i.e. curious, inventive, deep thinker). *Senior males* described themselves as being agreeable, conscientious, and open to experience like the senior females with the exception that senior males also described themselves as reverse neurotic (i.e. relaxed, emotionally stable, remains calm in tense situations).

In comparing across the four groups (freshman females, freshman males, senior females, and senior males), the highest value of items in a certain Big 5 category was in openness, which came from the freshman females with 7 corresponding FEAs. Female freshmen also had the most FEAs in the whole study with 25, whereas the remaining participant groups ranged between a total of 14 and 18 FEAs. In terms of gender, the senior male and senior female were very similar in number of FEAs across each category, as were senior males and freshman males. The only variance in senior male and freshman male was one reverse-neurotic FEA. Only the senior females and freshman females had items that were endorsed by 100% of the participants. 100% of the female senior participants recorded that they do a thorough job and like to cooperate with

each other, whereas 100% of the freshman females recorded that they are reliable workers and are kind and considerate to almost everyone.

The most significant difference shown in these results is between freshman females and senior females. Freshman females scored 5 extraversion related FEAs whereas senior females actually scored a positive 1 in the reverse extraversion category. This data could infer that female students become more introverted as they continue in engineering.

Table 2: Senior and Freshman Students' Big 5 Categories and Frequently Endorsed Adjectives (FEAs) to Describe Selves in Engineering Environment.

SENIORS					
Big 5 Factor	**Female FEAs**, N=14	%	Big 5 Factor	**Male FEAs**, N=27	%
C	Does a thorough job	100%	C	Does a thorough job	93%
A	Is helpful and unselfish with others	71%	O	Is original, comes up with new ideas	74%
O	Is curious about many different things	86%	A	Is helpful and unselfish with others	96%
C	Is a reliable worker	86%	N-R	Is relaxed, handles stress well	74%
O	Is ingenious, a deep thinker	79%	O	Is curious about many different things	74%
A	Is generally trusting	71%	C	Is a reliable worker	93%
O	Is inventive	71%	A	Has a forgiving nature	74%
C	Perseveres until the task is finished	79%	O	Has an active imagination	67%
O	Values artistic, aesthetic experiences	71%	A	Is generally trusting	78%
E-R	Is sometimes shy, inhibited	71%	N-R	Is emotionally stable, not easily upset	85%
A	Is considerate and kind to almost everyone	93%	O	Is inventive	70%
C	Does things efficiently	86%	C	Perseveres until the task is finished	85%
C	Makes plans and follows through with them	79%	A	Is considerate and kind to almost everyone	93%
A	Likes to cooperate with others	100%	C	Does things efficiently	93%
			N-R	Remains calm in tense situations	78%
			C	Makes plans and follows through with them	93%
			O	Likes to reflect, play with ideas	85%
			A	Likes to cooperate with others	70%

FRESHMEN					
Big 5 Factor	**Female FEAs**, N=12	%	Big 5 Factor	**Male FEAs**, N=29	%
E	Is talkative	92%	C	Does a thorough job	79%
C	Does a thorough job	92%	A	Is helpful and unselfish with others	79%
O	Is original, comes up with new ideas	83%	N-R	Is relaxed, handles stress well	66%
A	Is helpful and unselfish with others	92%	O	Is curious about many different things	79%
N-R	Is relaxed, handles stress well	67%	C	Is a reliable worker	79%
O	Is curious about many different things	92%	O	Is ingenious, a deep thinker	76%
E	Is full of energy	83%	A	Has a forgiving nature	79%
C	Is a reliable worker	100%	O	Has an active imagination	66%
O	Is ingenious, a deep thinker	67%	A	Is generally trusting	86%
E	Generates a lot of enthusiam	92%	O	Is inventive	69%
A	Has a forgiving nature	92%	C	Perseveres until the task is finished	69%
O	Has an active imagination	92%	A	Is considerate and kind to almost everyone	79%
A	Is generally trusting	83%	C	Does things efficiently	72%
N-R	Is emotionally stable, not easily upset	83%	N-R	Remains calm in tense situations	69%
O	Is inventive	92%	C	Makes plans and follows through with them	76%
E	Has an assertive personality	75%	O	Likes to reflect, play with ideas	69%
C	Perseveres until the task is finished	83%	A	Likes to cooperate with others	72%
O	Values artistic, aesthetic experiences	83%			
A	Is considerate and kind to almost everyone	100%			
C	Does things efficiently	83%			
N-R	Remains calm in tense situations	75%			
O-R	Prefers work that is routine	67%			
E	Is outgoing, sociable	75%			
O	Likes to reflect, play with ideas	83%			
A	Likes to cooperate with others	83%			

Note: A=Agreeableness, C=Conscientiousness, E=Extraversion, N=Neurotic, O=Openness, N-R= Reverse Neurotic, E-R=Reverse Extraversion, O-R=Reverse Openness

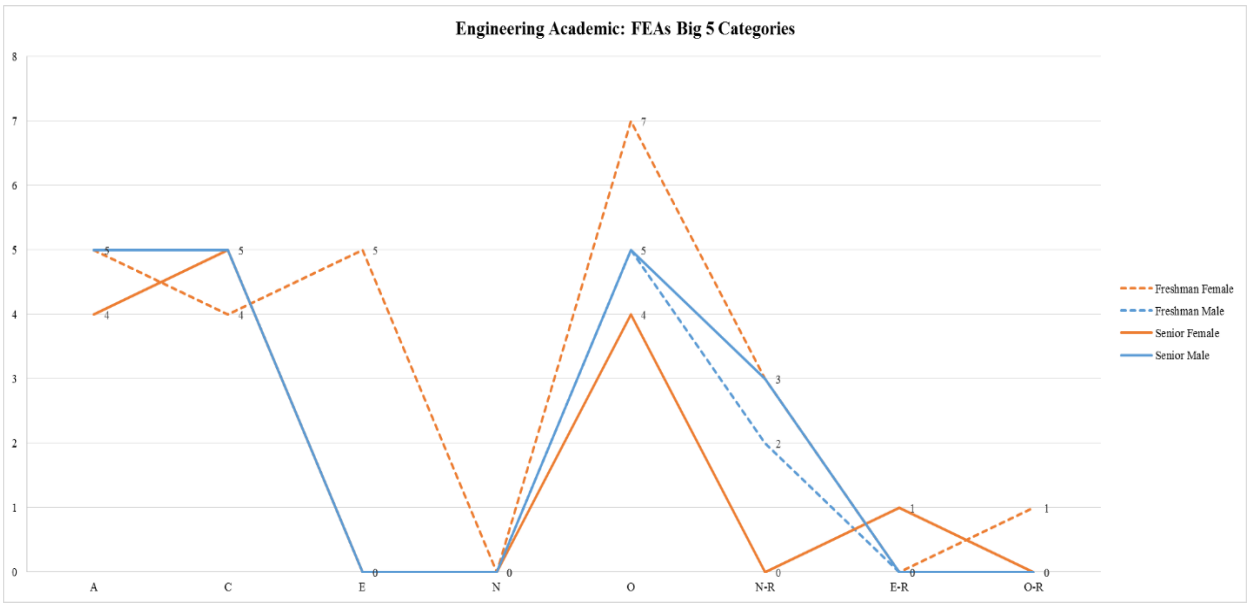

Figure 1: The number of Big 5 FEAs for students' description of *Self* in engineering academic settings. (*Note*: A=agreeableness, C=conscientiousness, E=extraversion, N=neurotic, O=openness, N-R=reverse neurotic, E-R=reverse extraversion, O-R=reverse openness)

RQ2: What variations in personality profiles and authenticity are present among engineering students' different roles in engineering and non-engineering environments?

Engineering Students' descriptions of self across engineering and non-engineering contexts. In addition to descriptions of self during academic engineering contexts, participants also provided descriptions of self in non-engineering contexts like social settings. The number of FEAs in non-academic settings were compared to the number of FEAs selected in the engineering environment for each participant group, displayed in **Figure 2** (freshman female top left, senior female top right, freshman male bottom left, senior male bottom right). There is good amount of similarity between the two contexts (engineering and non-engineering) for the freshman female, senior male, and freshman male participant groups. Some differences do exist though. For example, *freshman females* reveal a small distinction in their description of self during engineering and non-engineering contexts in the Big-5 factors of reverse neurotic and the reverse openness. This suggesting that in the engineering context, freshman females are more likely to describe themselves as " relaxed, handles stress well", "remains calm in tense situations", and "prefers work that is routine" in engineering settings. *Freshman males* also reveal a small distinction in their description of self during engineering and non-engineering contexts. Freshman males tend to be slightly more extraverted and displaying openness in non-academic contexts. *Senior males*, on the other hand, tend to be slightly more extraverted and displaying less openness in non-academic contexts. The *senior females* revealed and greatest variation between academic and non-academic environments, with conscientiousness as the only unchanged category. Agreeableness, extraversion, reverse extraversion, openness, and reverse neurotic all varied, with the greatest change being the extraversion category. This revealing that senior females tend to describes their self as more agreeable, more extraverted, displaying more openness, and being less neurotic in non-academic and non-engineering contexts. The greatest difference being extraversion. Such findings corroborate that female engineering students

become more introverted over time in academic/engineering contexts. This suppression of extraversion may not be a healthy sign for female students. Prior studies reveal that expressive suppression can affect social and personal behavior[23].

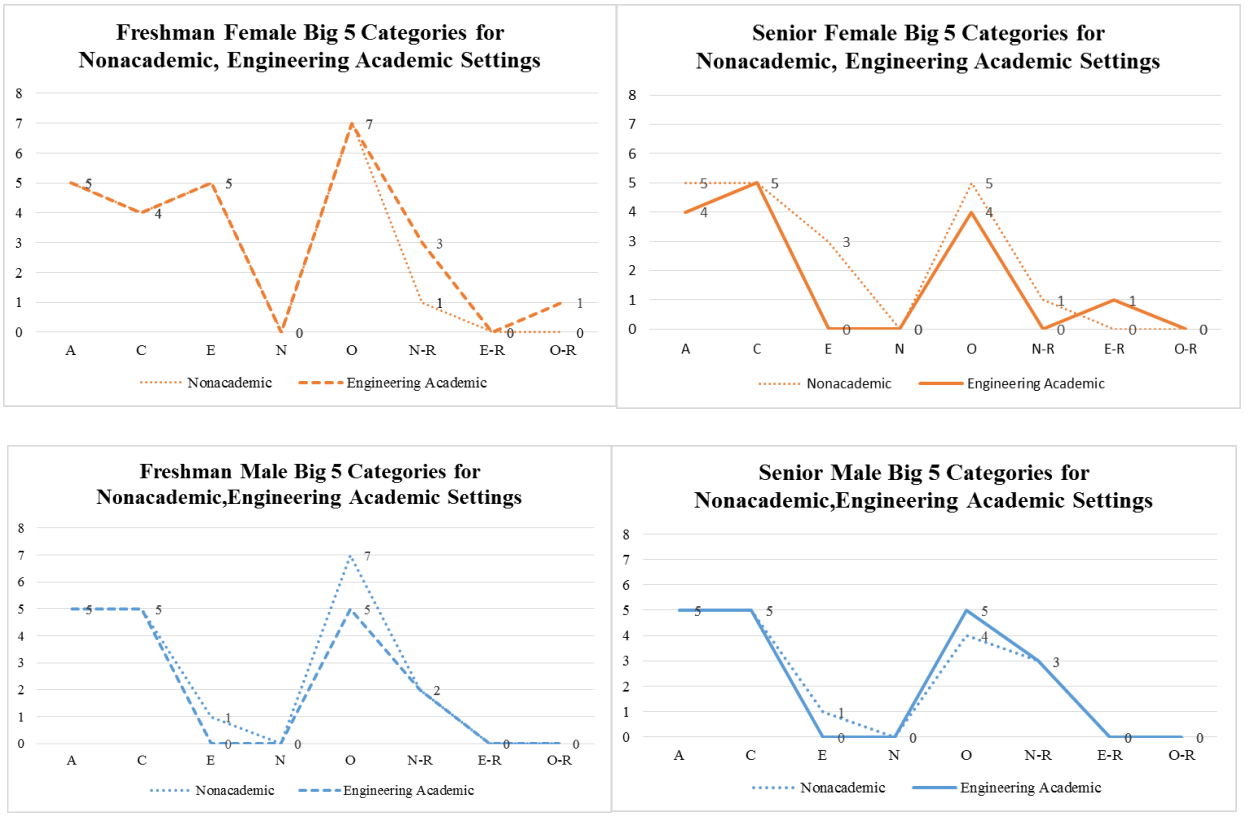

Figure 2: The number of Big 5 Category FEAs of students' personalities in nonacademic and engineering academic settings (freshman female top left, senior female top right, freshman male bottom left, senior male bottom right). (*Note*: A=agreeableness, C=conscientiousness, E=extraversion, N=neurotic, O=openness, N-R=reverse neurotic, E-R=reverse extraversion, O-R=reverse openness)

Engineering Students' Authenticity Variations between Engineering and Nonacademic Environments. While variation in personality across environments is natural, variation in authenticity across environments indicates conflict between one's true identity and forced identity[18]. An authenticity score was developed by taking the results of the five authenticity items in the survey and totaling the mean scores. Questions 4 and 5 were reverse-authenticity questions, so the means of those questions were subtracted by the highest possible ranking value (9) for each question, then totaled with the rest. **Table 3** displays the total authenticity score for each participant group comparing nonacademic and engineering environments. Little variation in authenticity between environments indicate stability while large variation considers conflict in one's feeling authentic in environments. The least authenticity variation came from the freshman female group, in which the scores were both rounded to the sum value of 36, and the highest authenticity variation was found in the senior female group. The senior female participants scored an authenticity score of 35 in nonacademic environments while they scored 28 in engineering academic environments, totaling in a difference of 7 authenticity points. Senior

males scored an authenticity score of 33 in nonacademic environments and 31 in engineering environments, while freshman males scored similar scores of 34 and 31 in nonacademic and engineering environments, respectively. These scores consider that female seniors feel a change in authenticity between the two settings, whereas the other participant groups may feel more authentic between them.

Table 3: Total authenticity scores between nonacademic and engineering academic settings separated into gender and academic level.

	Authenticity Score			
	Senior		**Freshman**	
Setting	**Female,** N=14	**Male,** N=27	**Female,** N=12	**Male,** N=29
Nonacademic	35	33	36	34
Engineering Academic	28	31	36	31

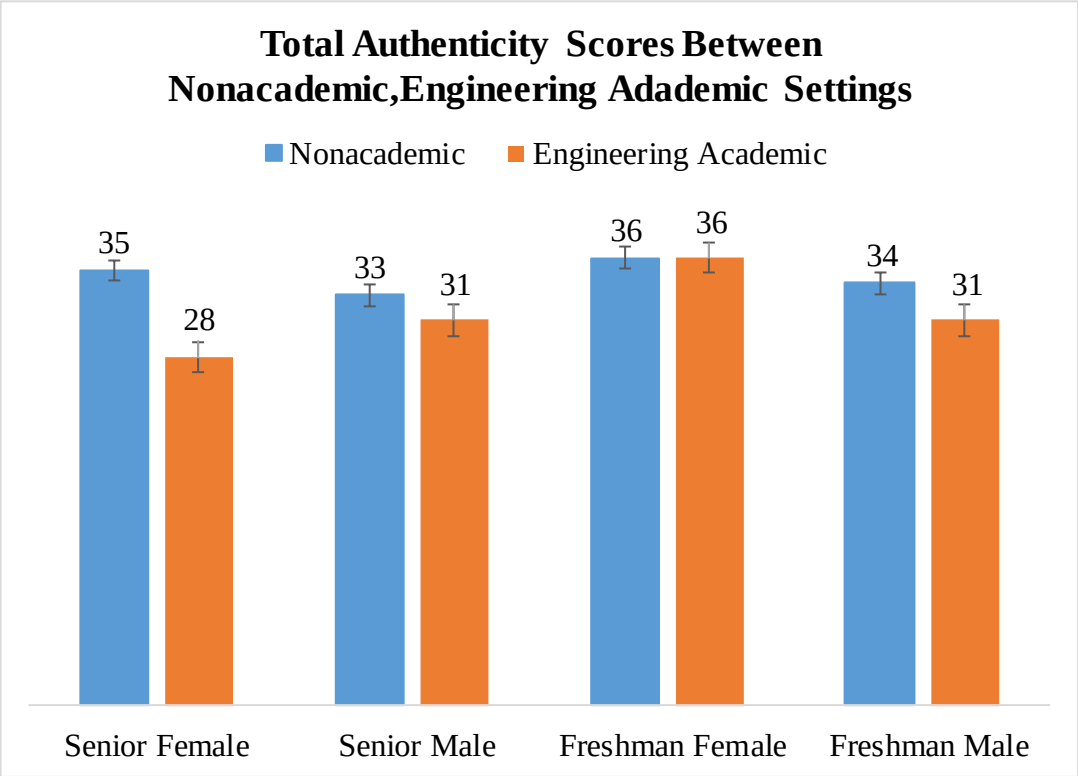

Figure 3: Total authenticity scores between nonacademic and engineering academic settings.

Referring to **Table 4**, which displays the mean values for each authenticity question, senior females show that they overall feel less authentic in the engineering environment than the other participant groups. Senior females scored the lowest mean values for items 1 and 3, and the highest for items 4 and 5, in which questions were posed to be reverse-authenticity questions. ***These results indicate that the senior female group feels the most tension and pressure in engineering, and feel less authentic to their personality in that environment.*** Results show that freshman females scored the highest in items 1 through 3, and the lowest in the reverse-

authenticity questions 4 and 5, indicating that they feel the most comfortable and authentic in engineering environments.

Table 4: Mean values for each authenticity item separated into gender and academic level in engineering academic settings. (*Note:* Mean scores are original values. Items 4 and 5 were reversed when totaling the authenticity score in Table 3 for consistency purposes.)

Authenticity Mean Values by Item for Engineering Academic Settings				
Item	**Senior**		**Freshman**	
	Female, N=14	**Male,** N=27	**Female,** N=12	**Male,** N=29
I experience this aspect of myself as an authentic part of who I am	5.64	6.78	7.45	6.52
This aspect of myself is meaningful and valuable to me	6.86	7.00	7.55	6.76
I have freely chose this way of being	6.36	6.96	7.64	7.03
I am only this way because I have to be	4.71	3.96	2.64	4.28
I feel tense and pressured in this part of my life	6.14	5.59	3.73	5.10

Conclusions

This study was produced to explore engineering identity and self concept differentiation (SCD) by an investigation of freshman and senior engineering students' personality and authenticity. Two key previous studies laid a strong foundation to carrying out our work herein - Casto et al.[11] and Sheldon et al.[18]. More specifically, we used a novel approach to measuring personality using adjectives derived from the Big 5 Factors framework[11] and also measuring authenticity[18], which adds to our understanding of identity and SCD. Key findings of this study include:

- Overall, engineering students described their self with higher levels of agreeableness (i.e. helpful, trusting, considerate), conscientiousness (i.e. thorough, reliable, follows through with plans), and openness to experience (i.e. curious, inventive, deep thinker).
- Female engineering students showed a significant difference in extraversion factors between the freshman and senior classes. The results show that female engineering students become more introverted as they continue in engineering. They may not lose their extraversion in nonacademic settings, though, considering that they compress their extraversion in engineering environments. It is also considered that female students with high extraversion levels in engineering environments that do not compress their extraversion or become more introverted transfer out of engineering.
- Senior females show the greatest personality and authenticity variation between environments. The senior female group's engineering environment personality was very similar to the senior male and freshman male groups. This could mean that the longer females persist in engineering, they conform their personality to be like the dominant male personality. Senior females did result in the greatest authenticity variation out of all the groups between nonacademic and engineering environments.

Limitations

This study consists of several limitations that could be considered within the context of this investigation. An important limitation is the small sample size N, especially in the female engineering groups, and the lower response rates. Thus, the generalizability of these results is not strong. The study only gathered data from freshman and senior engineering students at one participating university, thus again minimizing the ability to generalize. The students who participated also represented a cross-sectional sample. A better design would have been longitudinal data and tracking the same freshman students over time. Such a study though, takes more forethought and time to achieve. Further, it is possible that coded items could affect the validity of the results.

Implications and Future Work

With these findings, we want to imply that personality and authenticity differences among engineering students may be an attribute towards their persistence in engineering programs. Identity, personality, and authenticity studies have only recently been associated with program retention. Future work for this study would include administering the survey to a larger sample of engineering students to validate that our findings can be corroborated with a larger sample. Qualitative data collection and analysis in relation to persistence in engineering is also another piece that is essential to understanding alignments between personality and authenticity results and retention trends. Through this future work, we would be able to understand the relation between students' personality and authenticity in and out of engineering settings, and their feelings towards persisting.

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1. US Congress Joint Economic Committee. (2012). STEM Education: Preparing for the Jobs of the Future. *Washington DC*.
2. Statistics. (2015). National Girls Collaborative Project. Retrieved June 15, 2015, from http://www.ngcproject.org/statistics.
3. Women, Minorities, and Persons with Disabilities in Science and Engineering. (2015). Retrieved June 15, 2015. From www.nsf.gov
4. Burke, P.J. (1991). Identity processes and social stress. *American Sociological Review, 56,* 836-849.
5. Spears, R., Doosje, B., Ellemers, N. 1997. Stereotyping in the face of threats to group status and distinctiveness: The role of group identification. *Personality & Social Psychology Bulletin, 23,* (538-553).
6. Boros, S. (2008). Organizational identification: Theoretical and empirical analyses competing conceptualizations. *Cognition, Brain, Behavior, 8,* 1-27.
7. Dehing, A., Jochems, W., & Baartman, L. (2013). The development of engineering students professional identity during workplace learning in industry: A study in Dutch bachelor education. *Engineering Education, 8*(1), 42-64.

8. London, B., Rosenthal, L., Levy, S. R., & Lobel, M. (2011). The influences of perceived identity compatibility and social support on women in nontraditional fields during the college transition. *Basic and Applied Social Psychology*, *33*(4), 304-321.
9. Hughes, R. (2014). The Effects of a Single-Sex STEM Living and Learning Program on Female Undergraduates' Persistence. *International Journal of Gender, Science, and Technology, 6*(1), 26-54.
10. Meyers, K. L., Ohland, M. W., Pawley, A. L., Silliman, S. E., & Smith, K. A. (2012). Factors relating to engineering identity. *Global Journal of Engineering Education*, *14*(1), 119-131.
11. Casto, K., Chase, B., Pierrakos, O., & Anderson, R. (2011, December). Female and Male Engineering Students' Personality Characterization of Successful Engineering Students, Engineers, and Themselves. In *Advancing Women: Transforming Engineering Education.*
12. Donahue, E. M., Robins, R. W., Robert, B. W., & John, O. P. (1993). The divided self: Concurrent and longitudinal effects of psychological adjustment and social roles on self concept differentiation. *Journal of Personality and Social Psychology*, *64*, 834-846.
13. Lutz, C. J., & Ross, S. R. (2003). Elaboration versus fragmentation: Distinguishing between self-complexity and self-concept differentiation. *Journal of Social and Clinical Psychology*, *22*, 537-559.
14. McCrae, R. R., & John, O. P. (1998). An introduction to the five-factor model and its applications. *Personality: critical **concepts** in psychology*, *60*, 295.
15. Gosling, S. (2003). A Very Brief Measure of the Big-Five Personality Domains. *Journal of Research in Personality, 37*, 504-528.
16. Said, H. M., KhamisAbukraa, M., & Rose, R. M. The Relationship between Personality and Job
17. Ozer, D. J., & Benet-Martinez, V. (2006). Personality and the prediction of consequential outcomes. *Annu. Rev. Psychol.*, *57*, 401-421.
18. Sheldon, K. M., Ryan, R. M., Rawsthorne, L. J., & Ilardi, B. (1997). Trait self and true self: Cross-role variation in the Big-Five personality traits and its relations with psychological authenticity and subjective well-being. *Journal of Personality and Social Psychology*, *73*(6), 1380.
19. Colvin, C. R., Funder, D. C. Jun 1991. Predicting personality and behavior: A boundary on the acquaintanceship effect. *Journal of Personality and Social Psychology*, 60(6), 884-894.http://dx.doi.org/10.1037/0022-3514.60.6.884
20. Maltby, J., Wood, A. M., Day, L., & Pinto, D. (2012). The position of authenticity within extant models of personality. *Personality and Individual Differences*, *52*(3), 269-273.
21. Strack, S. (1987). Development and validation of an adjective check list to assess the Million personality types in a normal population. *Journal of Personlaity Assessment*, *51*, 572-587.
22. Wood, A. M., Linley, P. A., Maltby, J., Baliousis, M., & Joseph, S. (2008). The authentic personality: a theoretical and empirical conceptualization and the development of the Authenticity Scale. *Journal of Counseling Psychology*, *55*(3), 385.
23. Srivastava, S., Tamir, M., McGonigal, K. M., John, O. P., & Gross, J. J. (2009). The Social Costs of Emotional Suppression: A Prospective Study of the Transition to College. *Journal of Personality and Social Psychology*, *96*(4), 883–897. http://doi.org/10.1037/a0014755