Assessing the GRIT of Incoming Engineering Students

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Dr. Laura Bottomley, ASEE Fellow, is the Director of Women in Engineering and The Engineering Place for K-20 Outreach and a Teaching Associate Professor in the Colleges of Engineering and Education at NC State University. She teaches an Introduction to Engineering class for incoming freshmen in the College and Children Design, Invent, Create, a course for elementary education students that introduces them to engineering design and technology as well as various electrical engineering classes.

In 2009 Dr. Bottomley was selected for a Presidential Award for Excellence in Mathematics, Science and Engineering Mentoring by the White House Office of Science and Technology Policy and by the Educational Activities Board of the IEEE for an Informal Education Award. She was also inducted into the YWCA Academy of Women in 2008 for her contributions to eliminating racism and empowering women and was selected as the 2011 Woman of the Year by the RTP chapter of Women in Transportation. In 2013 she was named one of 125 Transformational Women by NC State University.

In her role as director of The Engineering Place at NC State, Dr. Bottomley and her colleagues reach more than 10,000 students, 2000 teachers and 1500 parents each year. The programs she leads include summer camps for K-12 students; programs that send undergraduates and graduate students into schools to work with elementary and middle school students; training sessions for NC State engineering alumni who want to be volunteer teachers in their communities; and professional development and classroom support for K-12 teachers who want to introduce engineering concepts to their young students. In addition, she co-authored statewide engineering standards for K-12 and delivers teacher professional development in integrated STEM. Bottomley also directs NC State's Women in Engineering program, which works to boost the number of women engineers in academia and industry. The NC State Women in Engineering Program was selected as the outstanding program for 2008 by WEPAN, the Women in Engineering Program Advocates Network for the progress made in recruiting and retaining women students in engineering at NC State University. In addition to her roles at the University, Dr. Bottomley has taught fifth grade science as a volunteer consultant, helped schools reinvent themselves as engineering magnet schools and acted as a consultant to the N.C. Dept. of Public Instruction and Wake County Public Schools. She served on a national team for the National Assessment of Educational Progress developing an assessment for engineering and technological literacy, works with IEEE and the National Academy of Engineering on the Engineering Equity Extension Project and served as a curriculum consultant on a National Science Foundation Gender Equity grant. She also co-authored the Engineering Connections to STEM document published by the North Carolina Department of Public Instruction. She is currently serving on a committee with the National Academy of Engineering, Guiding the Implementation of K-12 Engineering.

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In the fall of 2014, the College of Engineering at NC State University surveyed 1500 incoming engineering students with the twelve question GRIT assessment originated by Angela Duckworth[1].The qualities associated with GRIT have been publicized recently in the popular literature, including the New York Times[6]. Previous research with other types of populations has indicated a correlation between measured GRIT and persistence in school-based achievements. This paper describes the results of this survey correlating measured GRIT with gender and ethnicity. GRIT scores will, in future, also be correlated with variables used to accept students to the College of Engineering, such as SAT scores and high school grades. This GRIT survey was administered as the beginning of a longitudinal study to compare the correlation of GRIT with retention-to-graduation with the correlation of admissions variables to retention-to-graduation. Admissions variables were originally selected because they predict retention; the study will examine whether GRIT is more, less or additionally predictive of student success.

Introduction

"Let me tell you the secret that has led to my goals. My strength lies solely in my tenacity."
Louis Pasteur

The Grit Scale was developed by Dr. Angela Duckworth in 2007[1] to measure the personality traits of perseverance and passion for long-term goals. In Duckworth 2009[2] The Short Grit Scale (Grit–S) was shown to have internal consistency, validity and improved psychometric properties. Various studies have associated GRIT, as measured by the Grit-S scale, with higher GPAs for adolescents, with retention for cadets at West Point Military Academy and final round attainment for participants in the Scripps National Spelling Bee. In Von Culin[3] researchers found that GRIT has two component vectors, namely perseverance of effort and consistency of interests. GRIT has also been shown by these researchers to be nearly orthogonal to intelligence.

Strayhorn[5] studied GRIT as a predictor of academic success of black college students at majority institutions. Rojas[4] studied GRIT among middle school students. So far, the populations studied have not included undergraduate engineering students. If GRIT is shown to correlate to longitudinal success, and students can be taught techniques for increasing their perseverance and engagement, then a correlation might lead to suggestions for the improvement of first year engineering programs, minority and women in engineering programs, or others. (Even though correlation is not causality, program changes that evidence shows may have an effect, and can be implemented with little or no cost, would have great appeal.) Yeager and Dweck, et al.[7] show that the belief that "intellectual abilities are qualities that can be developed (as opposed to qualities that are fixed)" can be causally linked to persistence and higher achievement in academics. These same researchers show that this "growth mindset" can be taught. Taken together, the work on GRIT as a predictive variable and the work on mindsets as a causal variable give indication that student persistence and success may well be able to be positively influenced.

The Study

In the fall of 2014, all first year engineering students were invited to participate in a longitudinal study that will track their semester by semester performance and persistence to graduation. Of the students invited, approximately 1600 students, 475 enrolled in the study. These students completed the 12 question Grit-S^2 assessment. After the end of the semester, the student responses were correlated with gender, ethnicity and semester GPA. For each student, a GRIT score was calculated by positively coding all responses (in the original test, items 2,3,5,7 and 8 are inversely coded). These data are stored (without names) in order to be compared with GPA and persistence data to be collected each semester. Figure 1 shows the results for each question (with the positive coding).

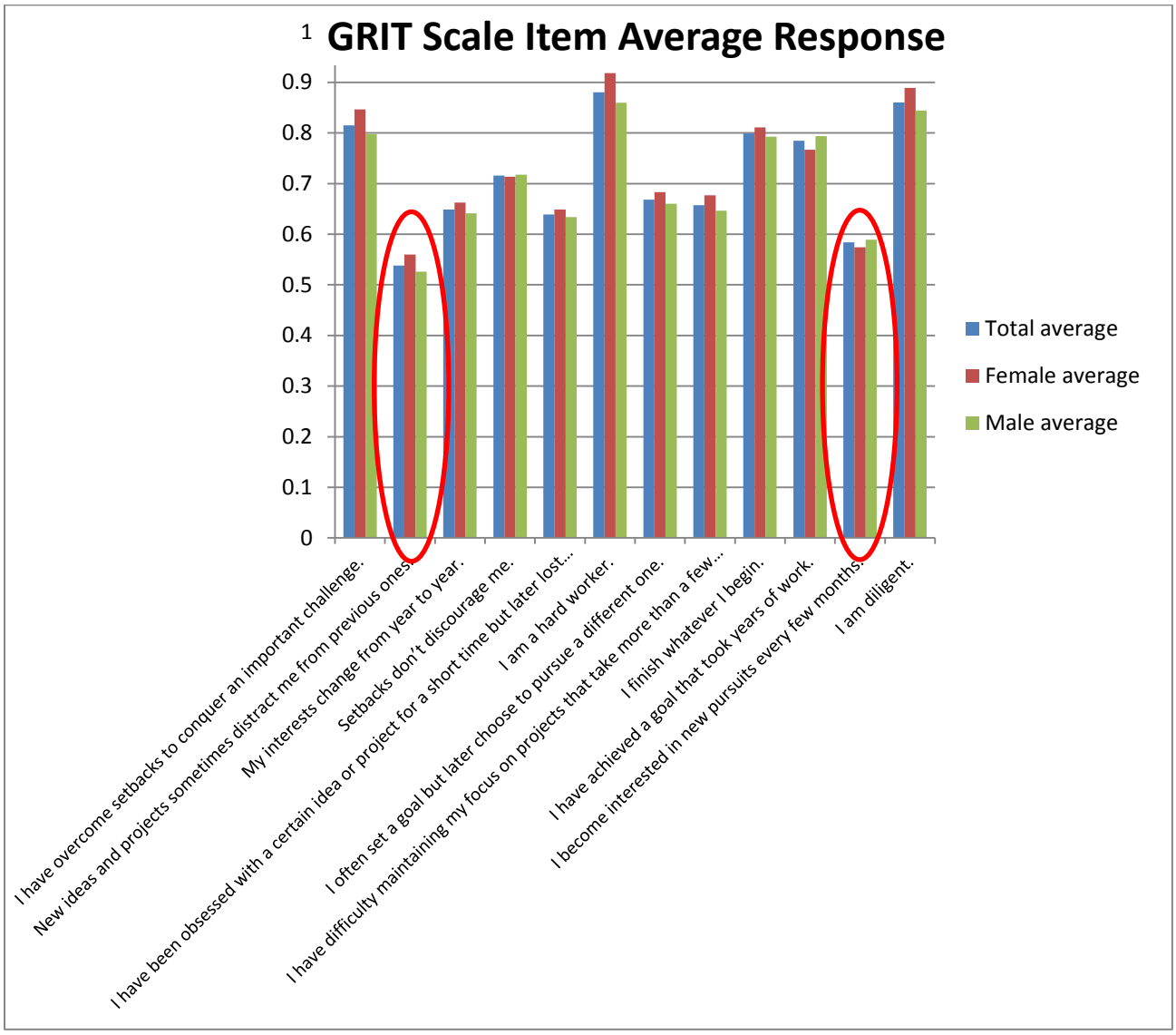

Figure 1: GRIT-S Scale item mean response overall and by gender, normalized

The students rated themselves relatively high, on average, for most of the categories. The lowest ratings indicated that they may consider themselves to be distractible and take on new interests fairly often, as indicated by the circled items in the figure. (Note: because the coding was reversed, question 2 indicates a student is less distractible as the bar increases. This reversal is necessary to get a composite GRIT score. In short, higher bars equate to more "gritty.")

The graph indicates differences in the male and female average response by item, but does not indicate whether those differences were significant, so a two sample independent T-test was used to look for significant differences by item. A two samples independent T-test was chosen because we were examining the difference between two groups (males versus females). In addition, the dependent variable was normally distributed, meeting the underlying assumptions of the two sample independent T-test. Table 1 gives the test results by test item.

Table 1: Results of t-test for Equality of Means by Gender and by Item

Item	Mean Difference	p-value	Std. Error Difference
I have overcome setbacks to conquer an important challenge.	.237	.003	.080
New ideas and projects sometimes distract me from previous ones.	.116	.073	.092
My interests change from year to year.	.115	.228	.094
Setbacks don't discourage me.	-.030	.750	.094
I have been obsessed with a certain idea or project for a short time but later lost interest.	.076	.428	.096
I am a hard worker.	.290	.000	.066
I often set a goal but later choose to pursue a different one.	.104	.250	.090
I have difficulty maintaining my focus on projects that take more than a few months to complete.	.141	.161	.100
I finish whatever I	.086	.297	.082

begin.			
I have achieved a goal that took years of work.	-.142	.196	.110
I become interested in new pursuits every few months.	-.063	.482	.090
I am diligent.	.213	.002	.070

As indicated by the highlighted rows, three of the items had statistically significant means, indicating that women view themselves as more hard working and diligent than the males in the sample and that women were more likely to say they had overcome setbacks to conquer a challenge. (There were 301 males and 174 females in the sample.)

Post hoc analysis was conducted using a one way Anova analysis to look for comparisons among students of different ethnicities. The students were classified into six categories by self-selected race: unknown, American Indian, Asian, Black, Hispanic and White. The analysis found statistically significant differences among groups in four items, 1, 6, 10 and 12. These results are summarized below.

The table of means by item is listed in table 2. The items where statistically significant differences between groups were found are highlighted. Readers may refer back to the means table to view differences in means as they look at tables 3-7. Tables 3-7 show the statistically significant differences by pairings with the relevant p-value.

Table 2: Mean item response by ethnicity

Mean response (on 5 point scale) by item number												
Ethnicity	1	2	3	4	5	6	7	8	9	10	11	12
Unknown (N=17)	4.36	3.00	3.27	3.90	3.45	4.73	2.82	3.18	3.82	3.73	2.45	4.45
Am. Indian (N=8)	3.75	2.88	3.00	3.13	3.63	4.50	3.00	3.13	3.75	4.38	2.88	4.63
Asian (N=54)	3.91	2.46	3.00	3.54	3.23	4.00	3.09	3.05	3.82	3.58	2.73	4.07
Black (N=23)	4.52	2.74	3.34	3.57	3.17	4.22	3.39	2.96	3.74	3.52	3.09	3.96
Hispanic (N=20)	4.25	2.70	3.35	3.40	3.05	4.40	3.55	3.05	3.70	3.5	2.55	4.35
White (N=351)	4.06	2.71	3.28	3.60	3.18	4.46	3.38	3.36	4.06	4.01	2.98	4.34

Item 1, *I have overcome setbacks to conquer an important challenge*, showed differences between black students and American Indian, Asian and white students, respectively. Black students rated themselves as having overcome setbacks more than did the three other groups in the table 3.

Table 3: Item 1 statistically significant difference pairings

Group 1	Group 2	p-value
Black	American Indian	.023
Black	Asian	.003
Black	White	.010

As indicated in Table 4, Item 6, *I am a hard worker*, showed differences between the responses of Asian students and those called themselves unknown, Hispanic or white. Asian students were the least likely to rate themselves highly as hard working.

Table 4: Item 6 statistically significant difference pairings

Group 1	Group 2	p-value
Asian	Unknown	.003
Asian	Hispanic	.035
Asian	White	.000

Item 10, *I have achieved a goal that took years of work*, showed differences between the responses of white students and those from the Asian, black and Hispanic groups. White students rated themselves significantly higher on having taken years to achieve a goal that the three groups in Table 5. (Note that the mean response for American Indian students was higher, but the differences are not statistically significant due to small sample size.)

Table 5: Item 10 statistically significant difference pairings

Group 1	Group 2	p-value
White	Asian	.008
White	Black	.041
White	Hispanic	.046

Finally, Item 12, *I am diligent*, showed differences among several different groupings. For this item, American Indian students and white students rated themselves as significantly more diligent than either Asian students or Black students. These pairings are listed in Table 6.

Table 6: Item 12 statistically significant difference pairings

Group 1	Group 2	p-value
American Indian	Asian	.043
American Indian	Black	.024
White	Asian	.009
White	Black	.013

Conclusions and Future Work

Some differences in the Grit-S measurement have been shown to be statistically significant by gender and ethnicity in this first cohort of 375 first year engineering students. At this point, seeking to explain those differences would rest on too little data; however, this project will continue. If similar behaviors are detected in future cohorts, attempts will be made to gather data (perhaps through focus groups) that might derive explanations for the findings. Additionally, breaking down differences by both ethnicity and gender may provide additional information.

Previous work with the GRIT scale has shown it to be at least somewhat predictive of success in the areas where it has been used: spelling bees, a military academy, middle school students and black men in majority white colleges and universities. If GRIT can be shown to be predictive in the case of undergraduate engineering students, two potential outcomes might occur. Because aspects of personality traits that make up the GRIT scale can, in fact, be taught, first year courses or programs to enhance student retention might be able to make important and impactful changes. Secondly, if GRIT is sufficiently predictive, as some earlier results suggest, some aspects of GRIT might be used to impact admissions or placement decisions, allowing students who are not able to show their capabilities on standardized metrics to have an additional input to the admission decision process. This project will continue to track the first cohort over their undergraduate experience and will also college a second cohort in the fall of 2016. Future results should prove interesting!

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