Grit and Two-Year Engineering Retention

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***Abstract*— This work-in-progress paper describes an exploratory investigation of the relationship between Grit and retention of engineering students. Grit is a noncognitive trait that psychologists have used to predict success more accurately than cognitive traits like intelligence. We administered the Grit Scale in a first-year engineering design project course (n = 465). Using binary logistic regression, we found that Grit was not a significant predictor of retention, but one of Grit's subscales, Perseverance of Effort, was significant for both one- and two-year retention in engineering. Our results suggest that we may be able to improve retention by helping students develop persistence to overcome their challenges and difficulties.**

Keywords— grit; engineering retention

I. Introduction

This work-in-progress study investigates the relationship between Grit and retention of engineering students after students' first two years at a large public university in the western United States. This paper is a continuation from the previous Grit study [1].

Grit is defined as "perseverance and passion for long-term goals" and "entails working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress" [2, pp. 1087-1088]. Grit is measured using the Grit Scale, developed by Duckworth et al. [2]. The Grit Scale consists of two subscales of equal weight that comprise Grit: Perseverance of Effort and Consistency of Interest. Items on the Grit Scale are rated using a 5-point scale from 1 = *not at all like me* to 5 = *very much like me* on statements such as "I am a hard worker" and "I often set a goal but later choose to pursue a different one" [2, 3]. We used the 8-item Grit Scale [3], which has four items per subscale, because of its improvements over the original 12-item Grit Scale [2].

The original Grit studies reported that Grit demonstrated incremental predictive validity of success measures beyond IQ and Conscientiousness [2, 3]. Furthermore, Grit was reported to be a better predictor of summer retention for freshmen cadets at the U.S. Military Academy, West Point than West Point's Whole Candidate Score [2, 3]. In a more recent study, Grit predicted retention in the military, workplace sales, high school, and marriage beyond established predictors such as, intelligence, physical aptitude, Big Five personality traits, and job tenure [4].

The motivation of our study was to determine whether Grit could be applied to retention in engineering. Previous studies have applied the Grit Scale to engineering students, but there were no published results on Grit's impact on retention [5, 6]. We also consider students' first math course grades influence on retention because students' performance on their college math courses impacts retention [7, 8].

In our study, we address two main research questions: (1) Does the Grit Scale predict retention for engineering students after two years? (2) Do moderating variables, such as the first math course grade, strengthen or weaken the relationship between Grit and retention?

II. Administering the Grit Scale

A. Participants

The 8-item Grit Scale [3] was completed by first-year engineering students through an online survey at a large public university in the West during the first week of the Fall 2014 and Spring 2015 semesters. The survey was part of a larger survey and administered in a first-year engineering design course. This course was only required for some engineering majors. Survey participation was optional, yet we had a 99% response rate from the students enrolled in the course. In total, about half of the college-wide first-year engineering cohort took the survey.

We obtained student information such as demographic, retention, and performance data from institutional databases and collated this information with individual Grit responses. Students' consent was obtained through an online consent process and there was no compensation offered for participating in the survey. The survey was implemented under the University of Colorado IRB Protocol 11-0651.

B. Data Analysis

We defined engineering retention using the following criteria: continuous enrollment in the university and continuous enrollment in an engineering major in the college of engineering. For example, students who changed majors within engineering were considered as retained. However, students

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who had left the college of engineering after their first semester but returned to the college of engineering for their third semester were not considered retained. For two-year retention, students had to be continuously enrolled in the university as an engineering major over their first two years.

We combined survey data from both Fall 2014 and Spring 2015 semesters because these students were part of the same first-year cohort. Out of the 621 survey participants, we excluded all students who were not first-year students, such as upper classmen or transfer students. We also excluded pre-engineering students because they were not enrolled in the college of engineering at the university. Eighteen students had missing items on the Grit Scale, but we kept four of the students who had at least one completed subscale from the Grit Scale. Table I shows the demographic information for the population we analyzed.

TABLE I. STUDENT DEMOGRAPHICS

	Grit Survey Respondents			**College-wide First-Years**
Group	***Fall 2014***	***Spring 2015***	***Analyzed data***	***Fall 2014***
Asian	13	26	30 (6.5%)	76 (8.4%)
Black or African American	1	1	2 (0.4%)	5 (0.6%)
Hispanic or Latino	34	37	59 (13%)	102 (11%)
Native American or Alaskan Native	0	3	2 (0.4%)	3 (0.3%)
Two or more races	17	11	19 (4.1%)	39 (4.3%)
Caucasian	200	203	318 (68%)	601 (66%)
International	20	53	36 (7.7%)	80 (8.8%)
Male	220	239	325 (70%)	666 (73%)
Female	66	96	140 (30%)	243 (27%)
Total	286	335	465 (51%)	909

Out of 465 in the sample, 384 students were retained after their first year (82.6% one-year retention rate). Thirty-one students changed majors to outside of engineering, and 50 students did not return to the university. Out of the 50 students who did not return, 22 were on academic suspension. After the second year, an additional 43 students were not retained (73.3% two-year retention rate).

We used binary logistic regression to determine whether Grit was a significant predictor of engineering retention. We used R as our statistical software package. In binary logistic regression, the predictor coefficient, β, is used to calculate the odds ratio (OR) using Eq. (1). The probability of retention is denoted as q in Eq. (1) and (2). We can interpret the OR using units of standard deviation when predictor variables are normalized.

$$\mathrm{OR} = \exp(\beta) = \exp(\mathrm{logit}(q)) \quad (1)$$

$$\mathrm{logit}(q) = \ln(q/(1-q)) \quad (2)$$

III. PRELIMINARY RESULTS

In our previous study [1], we found that Grit was not a significant predictor of one-year retention using the standard significant level of $\alpha = .05$ ($\beta = -0.14$, OR = 0.87, $p = .25$). In our most recent calculations, we found that the output values for the regression model were different ($\beta = 0.18$, OR = 1.19, $p = .148$). This new calculation was still consistent with [1] in that Grit was not a significant predictor of one-year retention. However, we also found that one of Grit's subscales, Perseverance of Effort (PE), was a significant predictor of one-year retention ($\beta = 0.37$, OR = 1.45, $p = .002$). That is, an increase of one standard deviation in PE increased the odds of being retained after one year by 45% when compared to the odds of a student being retained with an average PE score.

In this study, we found a similar result for two-year retention where Grit was not a significant predictor ($\beta = 0.14$, OR = 1.15, $p = .197$), but PE was ($\beta = 0.33$, OR = 1.40, $p = .002$). However, when we recategorized students as being retained despite interrupted enrollment in engineering (i.e., students who came back to engineering by the second year after having left the university or the engineering major), PE was no longer significant ($\beta = 0.14$, OR = 1.15, $p = .217$).

We looked at the influence of students' first math grades on retention (MGPA). We found that MGPA was significant in one-year retention ($\beta = 0.70$, OR = 2.01, $p < .001$), two-year retention ($\beta = 0.82$, OR = 2.26, $p < .001$), and recategorized two-year retention ($\beta = 0.78$, OR = 2.19, $p < .001$).

When we controlled for both PE and MGPA in the regression model as seen in Eq. (3), we found that PE was still significant for one-year retention ($\beta_1 = 0.30$, OR = 1.35, $p = .024$) and for two-year retention ($\beta_1 = 0.23$, OR = 1.26, $p = .050$), but not for the recategorized two-year retention ($\beta_1 = 0.01$, OR = 1.01, $p = .944$). MGPA was significant for all three cases: one-year retention ($\beta_2 = 0.65$, OR = 1.91, $p < .001$), two-year retention ($\beta_2 = 0.78$, OR = 2.18, $p < .001$), and recategorized two-year retention ($\beta_2 = 0.79$, OR = 2.19, $p < .001$).

$$\mathrm{logit}(q) = \beta_0 + \beta_1(\mathrm{PE}) + \beta_2(\mathrm{MGPA}) \quad (3)$$

Refer to Table II to interpret the output of our regression model using the mean and standard deviation of significant independent variables. For this administration of the Grit Scale, the Cronbach alpha value for Grit was .75, and the values for its two subscales, Perseverance of Effort and Consistency of Interest, were .71 and .78, respectively.

TABLE II. MEAN AND STANDARD DEVIATION OF SIGNIFICANT INDEPENDENT VARIABLES

	Independent Variables		
	Grit	***PE***	***MGPA***
Mean	3.54	3.88	2.68
Standard Deviation	0.53	0.58	0.87

We then tested the regression model with the interaction term for PE and MGPA included to understand PE as a moderator variable. The regression model is described by Eq. (4), and the interaction term can be seen in the third term that includes both PE and MGPA as normalized predictor variables.

$$\text{logit}(q) = \beta_0 + \beta_1(\text{PE}) + \beta_2(\text{MGPA}) + \beta_3(\text{PE})(\text{MGPA}) \quad (4)$$

Based on our data, the coefficient for the interaction term was not significant for any of the three retention cases: one-year retention (β_3 = -0.06, $p < .657$), two-year retention (β_3 = 0.01, $p < .904$), and recategorized two-year retention (β_3 = 0.10, $p < .361$).

IV. Discussion

Duckworth et al. [2][3] claimed that Grit was a better predictor of success than either of its two subscales independently. However, based on our preliminary results, we see that the PE subscale was a significant predictor of one- and two-year engineering retention whereas Grit itself was not. We also found that PE is a significant predictor of one- and two-year engineering retention when controlling for MGPA. With respect to moderating variables, we found that the regression models including the interaction term for PE and MGPA were not significant.

In another meta-analysis [9], researchers found that Grit was only moderately correlated with retention and strongly correlated with Conscientiousness. Furthermore, their results suggested that the primary utility of Grit may lie in the PE subscale. This finding about PE was consistent with our results. It may be that PE or Conscientiousness is what we should seek to develop in our engineering students to help them persist. Perhaps helping students persist and succeed in their first college math course may be most promising interventions to improve engineering retention.

The significance of PE disappears for two-year retention when we consider returning students who had previously left the university or the college of engineering as retained (or the recategorized two-year retention case). We do not yet know how to explain this difference in recategorized two-year retention.

V. Future Work

For future work, we will need to consider how students' academic standings affect the interpretation of our results. We are in the process of determining how to integrate students' academic standing in our data analysis for two-year retention as most of the returning students in the recategorized two-year retention case were previously on academic suspension. Furthermore, we will consider other interaction terms such as gender and ethnicity to identify students who may benefit most from improving their PE.

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