Grit and First-Year Retention in Engineering

Dong San Choi[1], Beth Ann Myers[2], and Michael C. Loui[3]
[1]Department of Electrical and Computer Engineering
University of Illinois at Urbana-Champaign, Urbana, IL
Email: choi88@illinoi.edu
[2]University of Colorado Boulder, Boulder, CO
Email: beth.myers@colorado.edu
[3]Purdue University, West Lafayette, IN
Email: mloui@purdue.edu

***Abstract*— Recently "grit" has been defined by psychologists as a personal attribute that correlates with persistence through difficulties. We present our preliminary findings on grit and engineering students in this work-in-progress paper. We administered the Grit Scale in a first-year engineering design project course in a large public university in Fall 2014 and Spring 2015 (*n* = 475). Using binary logistic regression, we showed that grit alone was not a significant predictor of retention in engineering. For future work, we will include two-year retention data and also consider moderating variables such as gender and ethnicity to determine whether their interaction with grit tells a different story. If the moderating variables reveal that grit is more important in retaining students with certain attributes, the Grit Scale may be useful in identifying at-risk students. If not, however, we will need to reconsider the Grit Scale when it is applied to engineering students.**

Keywords— grit; retention; first-year engineering

I. Introduction

In this work-in-progress paper, we present our preliminary findings on grit and engineering students. Duckworth et al. [1] defined "grit" 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" (pp. 1087-1088). To measure grit, Duckworth et al. [1] developed the Grit Scale. They showed that Grit Scale scores predicted the summer retention of freshmen cadets at the U.S. Military Academy, West Point, better than self-control, conscientiousness, and a composite score used in West Point's admissions process [1][2]. Duckworth et al. also showed that GPA and SAT scores were correlated to Grit Scale scores [1][2]. The motivation for our study was to determine whether the Grit Scale could also be applied to first-year engineering students. Previous studies of grit and engineering students have not addressed whether the Grit Scale predicts first-year engineering retention [3][4].

We address two main research questions: (1) Does the Grit Scale predict retention for first-year engineering students? (2) Does the Grit Scale predict retention for first-year engineering students when moderating for different variables like demographics or academic performance? We answer the first question in this work-in-progress paper, and we will address the second question for future work. For moderating variables, we will consider student attributes such as gender, ethnicity, socioeconomic status, GPA, and ACT Math scores. If the moderating variables reveal that grit is more important in retaining students with certain attributes, the Grit Scale may be useful in identifying at-risk students. For example, grit may be more important for the retention of students with lower ACT Math scores. This possible result would suggest that students with low grit and low ACT Math scores may be more at-risk of attrition. These results will build our knowledge in understanding the relationship between grit, which has been posited as a domain-less trait, and first-year engineering retention.

Supported by the Campus Research Board at the University of Illinois at Urbana-Champaign and by the Dale and Suzi Gallagher Professorship in Engineering Education at Purdue University.

II. Administering the Grit Scale

A. Participants

During the first week of the Fall 2014 and Spring 2015 semesters, first-year engineering students at a public university in the West completed the 8-item Grit Scale [2] in an online survey. The survey was part of a larger survey that also asked about engineering identity and students' perceptions of their skills. Although the survey was not required, 99% of the first-year students enrolled in the courses participated. The survey was completed as part of their first-year engineering design courses. These courses were required for only some engineering majors. In total, about half of the college-wide entering first-year engineering cohort took the survey.

Student demographic, retention and performance information was obtained from institutional databases and collated with individual grit responses. Students agreed to participate via an online consent process and no form of compensation was offered for completing the survey. The grit survey was implemented under the University of Colorado IRB Protocol 11-0651.

B. Data Analysis

We defined retention as students who met the following criteria for Fall 2015: continued enrollment in the university and continued enrollment as an engineering major in the college of engineering. As a result, students who began in the college of engineering in Fall 2014 but not in Fall 2015 were considered not retained.

We combined data from both Fall 2014 and Spring 2015 because the students were part of the same first-year cohort, and because grit is considered to be a stable quality that does not change significantly over time [2]. From the 621 students who responded to the survey, we removed pre-engineering majors because pre-engineering was not considered a part of the college of engineering at this university. We plan to analyze data with pre-engineers in future work. We also removed transfer students and students who took the survey but were not a first year student beginning in Fall 2014. Table I shows the demographic information for the population we analyzed. Our resulting population was 475 with 389 students who were retained (81.9% retention rate). Thirty students changed majors to outside of engineering, and 56 students did not return to the university.

For our preliminary analysis, we considered grit, first-year cumulative grade point average (CGPA), and ACT Math scores. We used R as our statistical software package.

TABLE I. STUDENT DEMOGRAPHICS

	Grit Survey Respondents			**College-wide First-Years**
Group	***Fall 2014***	***Spring 2015***	***Analyzed data***	***Fall 2014***
Asian	13	26	30	76 (8.4%)
Black or African American	1	1	2	5 (0.6%)
Hispanic or Latino	34	37	59	102 (11%)
Native American or Alaskan Native	0	3	2	3 (0.3%)
Two or more races	17	11	20	39 (4.3%)
Caucasian	200	203	318	601 (66%)
International	20	53	44	80 (8.8%)
Male	220	239	332	666 (73%)
Female	66	96	143	243 (27%)
Total	286	335	475	909

There were four students who were missing CGPA, but all four were not retained after their first semester, and so, their first semester GPA was used as their CGPA. There were 45 students who took the SAT but not ACT, and so, their SAT Math scores were converted to an ACT equivalent score. Additionally, there were 22 international students who took neither the ACT nor SAT, and so, they were not included in the analysis when considering ACT scores.

III. PRELIMINARY RESULTS

Since neither grit nor CGPA nor ACT Math passed Shapiro-Wilks normality test, we used the non-parametric Spearman's correlation to describe the relationship between these variables. Grit was not correlated with CGPA ($n = 475$, $r_s = -.01$, $p = .84$) or with ACT Math ($n = 453$, $r_s = -.04$, $p = .44$). CGPA was positively correlated with ACT Math ($n = 453$, $r_s = .33$, $p < .001$).

We used binary logistic regression using each variable separately to predict retention for first-year engineering students. Predictor variables were standardized to be able to interpret the results in a more understandable way. By standardizing the variables, we could interpret the predictor coefficient β in the context of changes in units of standard deviation. We use β to calculate the odds ratio (OR).

Grit did not predict retention ($n = 475$, $\beta = -0.14$, OR = 0.87, $p = .25$) nor did ACT Math ($n = 453$, $\beta = 0.16$, OR = 1.17, $p = .20$), but CGPA was a better predictor of retention ($n = 475$, $\beta = 0.89$, OR = 2.45, $p < .001$). That is, an increase of one standard deviation in CGPA increases the odds of retention by a factor of 2.45. When all three variables were entered together into the binary logistic regression model (where $n = 453$), the results were similar: grit ($\beta = -0.14$, OR = 0.87, $p = .32$), ACT Math ($\beta = -0.11$, OR = 0.89, $p = .44$), and CGPA ($\beta = 0.93$, OR = 2.53, $p < .001$). Once again, CGPA was a significant predictor of retention while grit and ACT Math were not.

To check moderation between grit and ACT Math, we used grit, ACT Math, and their interaction term as inputs into the binary logistic regression model. The logistic regression outputs showed that none of the terms were significant: grit ($\beta = -0.13$, OR = 0.87, $p = .28$), ACT Math ($\beta = 0.15$, OR = 1.16, $p = .22$), and interaction term ($\beta = -0.01$, OR = 0.99, $p = .96$).

Similarly, when considering grit, CGPA, and their interaction term, we found that CGPA alone was a significant predictor while the other two terms were non-significant at a $\alpha = .05$ significance level: grit ($\beta = -0.05$, OR = 0.95, $p = .71$), CGPA ($\beta = 0.86$, OR = 2.36, $p < .001$), and interaction term ($\beta = 0.26$, OR = 1.29, $p = .08$).

IV. DISCUSSION

In our binary logistic regression models, the coefficient for grit is negative: having higher grit could reduce the student's chances of being retained in engineering. This result needs to be investigated further, but it answers our first research question: grit does not predict retention for first-year engineering students. In contrast, CGPA is a significant predictor of retention. This result is not surprising as students may be put on academic probation or suspension based on their first-year GPA. In our definition of retention, however, we did not distinguish those who left the university and those who simply changed majors. It is possible that both low and high GPA students chose to change into a major outside of engineering. In our sample, there were 13 students who had above a 3.0 CGPA that changed majors outside of engineering by their second year. We will need to consider the departers with different GPAs in future work. For ACT Math, the predictor coefficient is positive when entered alone in the binary logistic regression model and negative when entered simultaneously with grit and CGPA. However, regardless of the sign, ACT Math was not a significant predictor of retention in both cases. When checking for moderation, our results show that the interaction terms are non-significant for the two cases: (1) grit and ACT Math, and (2) grit and CGPA. With CGPA being the only significant term in the latter case, it is difficult to interpret the results.

Duckworth et al. [1][2] found that the Grit Scale was significant in predicting summer retention for West Point's freshman cohort. Grit was also found to be correlated with GPA ($r = .24$, $p < .01$) and SAT scores ($r = -.20$, $p < .001$) of 139 undergraduate psychology students [1]. However, our results shows the contrary on both academic performance and retention. Grit was not correlated with CGPA or ACT Math scores for our engineering student population. This result suggests that the Grit Scale may not be applicable to engineering students. A different instrument might be needed to measure grit for this population.

V. Future Work

We are not convinced that the Grit Scale is applicable to first-year engineering students in predicting retention. However, we will consider two-year retention in our future work. If we do find grit to be significant for two-year retention, we consider it worthwhile to improve retention in engineering by developing grit for students early in their college career. Also, our analysis has not yet taken into account individual attributes such as gender, ethnicity, and socioeconomic status. We will continue to investigate the interaction of these attributes with grit in predicting retention.

References

[1] A. L. Duckworth, C. Peterson, M. D. Matthews, and D. R. Kelly, "Grit: Perseverance and passion for long-term goals," *J. Personality and Social Psychology*, vol. 92, no. 6, pp. 1087- 1101, June 2007.

[2] A. L. Duckworth and P. D. Quinn, "Development and validation of the short grit scale (grit-s)," *J. Personality Assessment*, vol. 91, no. 2, pp. 166-174, Feb. 2009.

[3] B. Jaeger, S. Freeman, R. Whalen, and R. Payne,, "Successful students: Smart or tough?" in Proc. Amer. Soc. Eng. Educ. Annu. Conf. and Expo., 2010.

[4] J. C. Chen, K. J. McGaughey, D. S. Janzen, J. T. Pedrotti, and J. M. Widmann, "Grit and its role in achievement among engineering students," presented at the 6th Research in Eng. Educ. Symp., Dublin, Ireland, 2015.