

## **AC 2010-1033: SUCCESSFUL STUDENTS: SMART OR TOUGH?**

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# Successful Students: Smart or Tough?

## Abstract

*Grit* is defined as perseverance and passion for long-term goals.<sup>5</sup> As a trait, grit has been measured in the educational realm and the associated metric has shown to reliably predict a significant percent of student ‘success’. This paper describes the initial work of an ongoing longitudinal study to measure the grit of first-year engineering students using a validated and established self-reporting survey tool.<sup>5</sup> Preliminary results of the survey show that there are significant differences in grit scores among student cohorts of gender and student athletes; there are some measurable differences across academic levels and differences among engineering majors. Trends exist between Honors and Non-honors students, yet there is little correlation with SAT scores or absolute age at the university level. Our hypothesis is that students can be better set up for success if they possess more grit, more toughness and determination. While both grit and success may be challenging to define and measure by some standards, we anticipate this research will provide new insights and direction for continued efforts in cultivating the engineers of 2020.

## Introduction

In recent years, there has been a shift in achievement-focused measures in the educational domain. Intelligence tests are earning less credibility while focus on effort-based activities abounds in an attempt to minimize the competitive element in educational experiences. In engineering, it is generally agreed that a baseline level of intellect, perception and ingenuity should be combined with a sufficient amount of perseverance, or *grit*, in order to succeed. One trait is rarely effective without the other. According to experts studying the features of grit, it is defined as perseverance and passion for long-term goals [and] entails working strenuously toward challenges, maintaining effort and interest over time, despite failure, adversity, and plateaus in progress.<sup>4</sup> How does this relate to our students in engineering?

For the last decade or two, Northeastern has had a strong focus –to do more than just teach engineering: that is, to set students up for success. The Undergraduate Deans in Northeastern University’s College of Engineering have put in place a strong team of advisors, tutors, and faculty for first-year engineering students. As noted, they have assembled a team of *Gateway* instructors dedicated to teaching first-year students as their full-time focus. As well, there are a multitude of mechanisms in place –both curricular and extracurricular– that support and assist the students if they avail themselves, and are served up even sometimes when they do not seek assistance. Remarkably, retention for this program has been remaining strong around 92% for many years. Other colleges at the University have adopted elements of this engineering education model with similar success. In addition, average SAT admissions scores at Northeastern University have also been rising.

So can we attribute part of the success to the “smarter” students we are selecting? To our talents as faculty? To the support programs? Considering that it is likely a combination of all of the

elements listed above –and some others that are less apparent– this new research takes another tack. The hypothesis, stemming from psychological research, is that success is better predicted by grit than measures of academic skill.

The operational definition of grit involves the ability –or propensity– to overcome obstacles, to persist through setbacks, maintain commitment, and to stick to projects and goals over long periods, even if interest wanes or the going becomes difficult. It is reportedly possible to quantify some aspects of this characteristic and map it to student success.<sup>4</sup> However, first we will discuss the benchmark predictors which are in current use.

### **Conventional Predictors of Success**

As educators we have all too often seen intelligent students who lack desire and ambition, these students sometimes will generate only average or even poorer quality work than peers of seemingly less talent. Conversely, we relish the students who might be described as less gifted for learning who triumph over their limitations to produce stellar work because they work hard and aspire to be the best. There has been a significant amount of research done attempting to qualify and quantify success in education, life, and career. This is a clear indicator of the complexity of the problem at hand and it is apparent that each of the measures developed will have calculated strengths and weaknesses. It is rare to find any metrics that are not subject to some criticism. The following paragraphs discuss seven measures of success or skill discussed in the literature.

**g.** One measure that is well established after over a century of research is general cognitive ability, or **g**, which predicts a broad spectrum of important life outcomes such as academic achievement, health related behaviors, job performance and social outcomes.<sup>11, 14</sup> But a high score in this single measurement is not a guarantee for success in the classroom or in the workforce. Life has the element of chance or –as some might say– bad luck.

**GPA.** Equally, examples abound of determined people who were high school or college “dropouts”, of only moderate **g**, that end up becoming triumphant in business and society. For these individuals, grade point average (GPA) is not a good predictor of success on the job and gives credence to the argument that the abilities required to succeed in school differ from those required to succeed in the real world. Kuncel’s work from 2004<sup>14</sup> contradicts the notion that success at work is altogether different from success at school which he stated is a popular misconception perpetuated by the fact that assessment is often developed for a particular setting –e.g., educational versus occupational. So in order to put grit into its proper context, we must first have a discussion on the various tests and measures created to measure intelligence, ability or success and note their prognostic strengths and weaknesses.

**IQ.** The Stanford-Binet Intelligence Test was developed in the early twentieth century and used a single number known as the intelligence quotient (IQ) to quantify a person’s intelligence. The percent value is calculated from dividing the result of a person’s mental age, derived from the test, by their chronological age. Binet believed that intelligence is far too complex to be quantified by a single value and stressed the limits of the value.<sup>13</sup> The Wechsler Intelligence Scales were developed by David Wechsler in 1955 to improve on the work of Stanford-Binet.

The tests have been refined several times over the years, and are given in different forms to children and adults. In its latest form, the WAIS-III, is broken into 14 subtests. The first eleven form the verbal and performance IQ numbers and the remaining two develop alternating scoring from letter-number sequencing and symbol search. The verbal portion tests vocabulary, comprehension, arithmetic, memory and attention while the performance portion analyzes visual perception, nonverbal reasoning and comprehension of social interactions. Unlike the Stanford-Binet test which uses chronological and mental ages to develop a quantitative estimate of intelligence, the WAIS-III compares the scores of those in the same age group.

**SAT and ACT.** Academia has its own standardized tests to predict success. The Scholastic Aptitude [Reasoning] Test (SAT) and its direct competitor the American College Testing (ACT) are both used in the college admission process. The SAT is administered through the nonprofit organization the College Board while ACT, Inc. manages the ACT. The SAT consist of three major sections: Critical Reading, Math and Writing, and the ACT is broken into four sections: English, Math, Reading and Science with an optional writing test.<sup>19,21</sup> The notable difference between the two is that the SAT is an aptitude test focusing on assessing reasoning and verbal abilities whereas the ACT is an achievement test measuring what was learned in school. In addition, scoring in the ACT is based only on the number of correct answers with no penalty for a guess while the SAT has a correction for answering wrong (guessing). Much research has been done trying to validate the use of these tests in the admissions process and conclusions have ranged from claims of unfair biasing towards females, minorities and low-income students to the composite score being a significant predictor of course grades from first-year to senior year.<sup>16</sup> In the context of predicting general intelligence, or *g*, Frey and Detterman show that it is possible to convert a SAT score to IQ, supporting the notion that SAT is an adequate measure of *g* and is a useful tool in predicting cognitive function.<sup>9</sup>

**GRE.** Graduate programs in the United States place varying emphasis on their version of the SAT or ACT Test called the Graduate Record Examination (GRE). The GRE is administered by the nonprofit Educational Testing Service or ETS which has the sole mission to advance learning. The test consists of three sections: Analytical Writing, Verbal Reasoning and Quantitative Reasoning. In the Analytical Writing section, the test taker will write two essays “Present Your Perspective on an Issue” and “Analyze an Argument”. Both are designed to assess articulation, examination and reasoning skills to name just a few. The Verbal Reasoning and Quantitative Reasoning sections measure: reading comprehension, verbal and analogical reasoning and basic concepts of arithmetic and data analysis respectively.<sup>22</sup> Similar arguments and criticisms of the GRE are made as with the SAT and ACT exams. For many test takers, scores are shown to improve after being familiarized with test taking strategies.

**MAT.** In addition to the GRE many social science and educational graduate programs use the Miller Analogies Test (MAT) created by Harcourt Assessment, Inc. Research has shown that performance on analogies involves multiple levels of cognition and that makes it a superb measure of *g*, verbal comprehension, and analytical thinking.<sup>1, 18</sup> Kuncel et. al. 2004<sup>14</sup> showed that the MAT and GRE measure abilities shared with other cognitive ability instruments, and that these abilities are generally valid predictors of both academic and vocational criteria.

**EI.** One final predictor of academic or vocational success that has gained considerable momentum is the concept of Emotional Intelligence or (EI). EI involves the ability to carry out accurate reasoning about emotions and the ability to use emotions and emotional knowledge to enhance thought.<sup>15</sup> Proponents of EI claim that in some instances measurement of intangible characteristics such as empathy, social maturity, and self awareness are better predictors of educational and occupational success and may be used to discern leadership among a group of candidates.<sup>10,17</sup> Criticism of EI measures is based around the multitude of qualities encompassed by the concept and its loosely defined nature with some authors describing overlap with personality constructs.<sup>17</sup> Assessment tests are ability-based (Multi-Factor Emotional Intelligence Scale), self-report based (Bar-On-EQ-I ) or mixed-model<sup>10</sup> with ability-based generally involving hands-on problem sets which are considered by most to be more accurate than self-reported.<sup>2</sup> A problem with self reporting is that it is susceptible to faking or exaggeration by the test taker.

While each of the metrics described above is designed to measure a specific cognitive ability such as a verbal or math skill, it has been observed that individuals who performed well on one type of test would tend to have a similar outcome on another. This overlap suggests that tools and tests designed to measure a specific element of one's cognitive and intellectual processing ability must also measure some general element that is common in all.<sup>12</sup> This is the basis of the argument for the general factor *g* mentioned earlier. We now look at another predictor of success: "grit".

### **Grit as a Predictor of Success**

A key question we are trying to address is "What are predictors for academic and future success?" If we can identify some of these predictors, then we can hope to find methods to cultivate and encourage –or at least not discourage– contributing traits and behaviors. Academic skills as measured by traditional metrics such as SAT scores or IQ tests are hypothesized to be less robust predictors. In the grit realm, one proposed predictor is self-control. As noted above, this research builds on previous work that has looked at predictors of success for both children and adults. Initial work focused on personality traits, such as self-discipline or self-control.<sup>6,7</sup> To summarize results, in one study, eighth graders and parents were surveyed on the students' self-control and IQ. When correlated with different period GPA's, achievement tests and selection to High School, validated self-control scores were more closely and statistically significantly correlated to these measures of success than IQ. In this same study, the author states, "Underachievement among American youth is often blamed on inadequate teaching, boring textbooks, and large class sizes. We suggest another reason for students falling short of their intellectual potential: their failure to exercise self-discipline". This concept of self-control, also defined as the ability to delay gratification, became part of another predictor, the concept of grit.

The key researchers in this area have a basic hypothesis: Grit is essential to high achievement, the short definition of grit being passion and perseverance for long-term goals as described previously. This evolved from extensive interviews with professionals in investment banking, painting, journalism, academia, medicine and law.<sup>4</sup> The quality identified by this group that was seen in star performers was grit –or a close synonym– as often as talent. In addition, that ambition and sustained commitment many times created successful people, where gifted

individuals had faded. They looked at IQ and personality as predictors of success, from past researchers, and found that these may not have the validity of grit. The first step was developing the grit scale; extensive work and testing created the highly tested and validated questionnaire currently in use.<sup>5</sup> Refer to Appendices A and B for the survey tool used to identify and score grit levels.

Once the grit scale was created and vetted, numerous studies on grit were conducted. A major research project gathered data through the web on over 1500 participants. One result of this large data set was that grit increases with age, but monotonically, so a 35 year-old is not significantly grittier than a 30 year-old. This study also established an association between grit and educational attainment. The result found to be significant was that more educated adults were higher in grit than those who were less educated in the same age group. This led to the next set of research to determine whether grit predicted performance of high achievers, so they evaluated GPA at an elite university. The conclusion: gritty students outperformed their less gritty peers.<sup>4</sup>

In the military, it would serve to reason that grit is a key component of success and leadership, so the next study looked at cadets at West Point Military Academy. The admission process is very grueling; much more is required of candidates than even at an elite university, for example a six event physical assessment, a letter from a congressman and demonstrated leadership abilities. Therefore, this is a different group from any previous studies. The first question concerned whether grit was connected to the survival of their summer training regimen, aptly named Beast Barracks. Grittier cadets survived, less gritty cadets did not (statistically significant). In addition, while grit was not a strong predictor of first-year success academically, nor a predictor of GPA or MPS (Military Performance score), self-control was a fairly good predictor. The authors surmise, “There is a qualitative difference between minor and major accomplishments. Earning good grades ... requires effort moment to moment, ... the workload is manageable and there is little temptation to give up altogether. Beast Barracks is deliberately engineered to test the very limits ... a reasonable response to the unrelenting dawn-to-midnight trials would be to exchange the goal of graduating West Point for a more manageable goal”.<sup>4</sup>

A study of children aged 7 to 15 yielded some consistent results, but with a slightly different model. The cohort was Scripps National Spelling Bee participants. Gritty children were seen to work harder and longer than their less gritty peers and, as a consequence, performed better. The model that arose from the results showed that study time and prior spelling bee experience also played a role. This model therefore, has these as logical mediators, that is, grit leads to more study time, which leads to spelling bee experience, which results in children making it to the final round.<sup>4</sup>

Duckworth et. al. 2007<sup>4</sup> evaluated numerous variables that affect success to understand confounding results and discuss other possible influences on success. They also freely review the limitations of their analysis and describe future work to resolve these. Nonetheless, their many studies and detailed analysis support their implications that “The qualitative insights of Winner(1996), Bloom(1985), and Galton (1892), coupled with evidence gathered by the current investigation and its forerunners, suggest that in every field, grit may be as essential as talent to high accomplishment.”

As the grit research gained momentum, it garnered the attention of others in the education and psychology fields and ultimately, the public. Jonah Lehrer, author of “How We Decide”, and columnist for the Boston Globe, penned an article titled “The Truth about Grit”. He quotes from interviews, “I’d bet that there isn’t a single highly successful person who hasn’t depended on grit,” says Angela Duckworth, a psychologist at the University of Pennsylvania who helped pioneer the study of grit. “Nobody is talented enough to not have to work hard, and that’s what grit allows you to do.” Lehrer references many of the studies discussed above.<sup>20</sup> But at the end of the article, it is pointed out that there is no secret recipe for increasing grit. He then suggests that an important element is required, this is, teaching kids that talent takes time to develop and requires continuous effort.

The notion of continuous effort is based on work by the Stanford psychologist, Carol S. Dweck.<sup>8</sup> In her work, she looks at “growth mindset”, which believes in time and effort, versus a “fixed mindset”, or the belief that achievement results from abilities we are born with. In her studies, children praised for their *intelligence* quickly became discouraged when given a version of an IQ test, contrasted to children that were praised for their *efforts*, who improved their final scores. This work, combined with the extensive work at the University of Pennsylvania, helps to set the stage for the search for how to increase student grittiness.

### **Motivation for This Work**

Given the extensive development process and supporting research, this first-year engineering faculty team has embarked on a study of grit in our students. Do they possess it as they come in as freshmen? Is it correlated to some of their other characteristics such as gender, academic level, or SAT scores? If we compare our data to that of upperclassmen, have our older students developed more grit? And, as we follow our students, do they persist—at least in part—perhaps because they possess more grit? Finally, if we determine that grit measures do serve as partial predictors of success, there may be potential in our role as first-year faculty in developing grit in our young engineers.

### **Methodology: The Grit Survey Tool**

**Procedures.** We administered the Grit Survey<sup>5</sup> to over 370 first-year students as they entered Northeastern University’s engineering program. The Grit Survey is included in Appendix A, used with permission; it was given to the incoming freshmen class of engineering students in their first couple weeks of class. It was administered online, with instructions for the students to be completely honest, that it was not graded, or even reviewed by their instructors; rather it was part of a large study. Naturally, there are limits and concerns with self-reporting. The originators of the survey have validated its internal consistency and also validated that self-report and informant-report results yielded consistent results with this tool. For thousands of surveys, the self-determined grittiness matched the grittiness reported by others, including friends, colleagues and family.<sup>5</sup> For our students, it is possible that they inflated or faked results, either to feel better about themselves or to show themselves as they want to be. We provided no incentive to do that, emphasizing that it is aggregated and stressing honesty as a key element. The survey was also administered to smaller groups of upper class students, both sophomores and seniors, to see if grit increases with academic level as defined by year of graduation.

**Grit Survey Subscales.** The Grit Survey has 4 subscales – Ambition (A), Perseverance of Effort (PoE), Consistency of Interest (CoI), Brief Grit (Grit-S or Brief) –plus an Overall Primary Grit (Grit-O or Total) measure. The Grit subscale associations as they relate to the Grit Survey are outlined in Appendix B. The trait of Ambition is characterized by achieving an important pursuit, being driven to succeed, identifying oneself as ambitious, and by wanting to be the best “in the world” at something, High PoE relates to overcoming challenges and setbacks, not being discouraged by setbacks, finishing projects, being a hard worker and achieving goals that take years to accomplish. Low CoI is identified by being distracted by new ideas, losing interest in projects, topics and ideas, shifting goals, having difficulty maintaining focus on long-term projects, or frequently moving to new pursuits. Brief grit drawn from abbreviated data, has been shown to be a strong forecaster of Total Grit, which is an aggregate of multiple factors. The subtleties of the Brief Grit and Total Grit scales will be discussed in the paper in more detail. Suffice to say that high values of the Brief grit subscale measures serve as a reliable gauge of Total/Overall Primary Grit.

## Results and Discussion

**Comparison to Other Populations.** In order to place our results in context, it is important to review results for key studies conducted on the Grit scale for different populations. These are listed in Table 1 below. The results for Northeastern University’s research initiative are *italicized* in the last row of the table. The range for mean grit is from 1 to 5, each question is scored on that basis.

**Table 1. Compilation of Prominent Grit Research**

Study, Year of Research	Sample size	Mean Overall Grit	Standard Deviation
1: Adults, 25 and older, 2007	1,545	3.65	0.73
2: Adults, 25 and older, 2007	690	3.41	0.67
3: Adults, ages 25-34, 2007	300	3.20	0.70
3: Ivy League Undergraduates, 2007	138	3.46	0.61
4: West Point Cadets, Class of 2008	1,218	3.78	0.53
5: West Point Cadets, Class of 2010	1,308	3.75	0.54
6: National Spelling Bee Finalists, 2007	175	3.50	0.67
<b><i>7: Engineering Freshmen, 2009</i></b>	<b><i>374</i></b>	<b><i>3.55</i></b>	<b><i>0.49</i></b>

These comparative results show that our first-year engineering students are on average grittier than the majority of cohorts from the literature: 3.55 versus 3.20, 3.41, 3.65, and 3.50 on the grit



scale and slightly more gritty than Ivy League undergraduates. The West Point cadets remain the highest at 3.75 for all cohorts (that is, the grittiest that survived “Beast Barracks”), even higher than older age groups. It appears that some level of determination is perceived and presumably possessed by our students; it takes grit to get into engineering school.

It is also interesting to note that our population of engineering students presents with the smallest standard deviation, the tightest set in terms of variability. This may be a result of their limited age range and homogeneity. Note that other low standard deviations come from the collegiate populations, so our results are consistent with their peers.

So our students appear to start out with a reasonable level of grit. We next examine the results to look for differences and trends in our engineering population. Some of the compelling questions are: Are there some groups that possess different composition of toughness, or ambition, who may be more consistent in their interests? Can we stratify, or identify any characteristics within certain groups?

**SAT Scores.** Pearson’s Product Moment Correlation calculations provide no evidence for an association between SAT scores and Grit measures. That is, higher SAT scores are not correlated with higher grit levels. The highest positive  $R$ -value was 0.04 and several showed low negative coefficients. These negative values would suggest that better performance on a standardized achievement test might be weakly associated with less grit. However, we have no statistical evidence to link the verbal or mathematical SAT scores to any of the Grit measures.

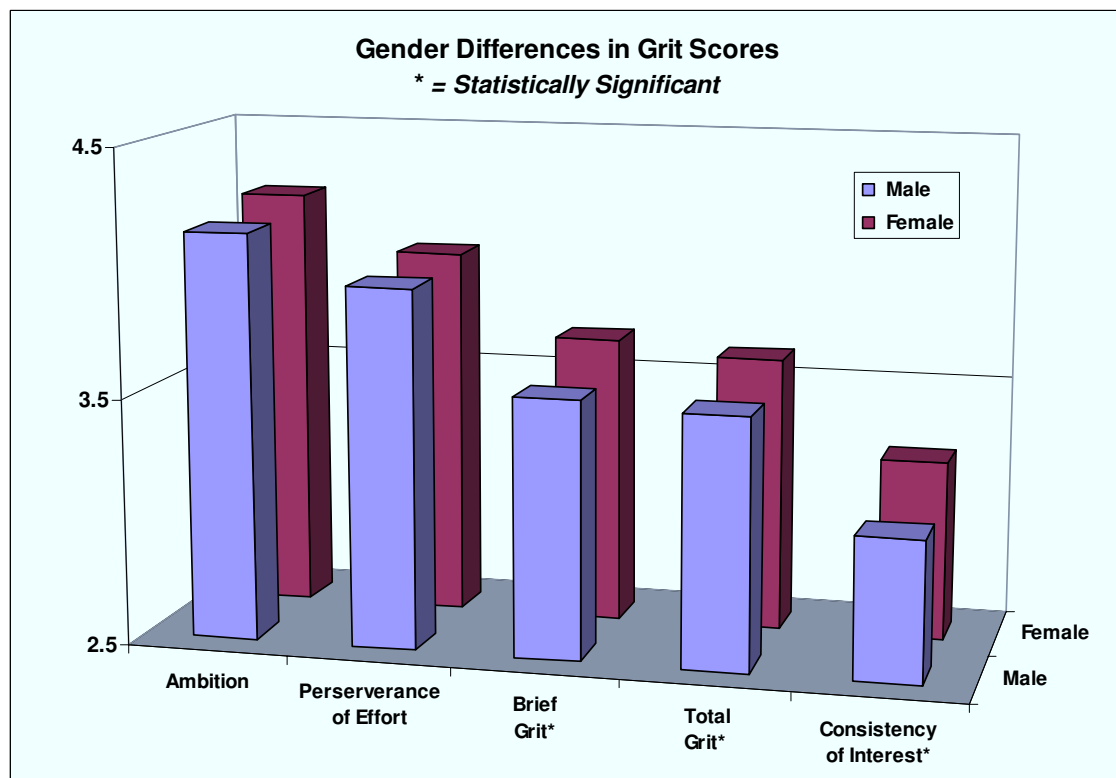


Figure 1. Gender differences in Grit measures all Engineering Levels.

**Gender Differences.** Significant gender differences are seen in Brief and Total Grit and CoI (Consistency of Interest) across all age levels, first-year to senior (Figure 1, above). A nearly identical profile is seen for first-year students, shown in Figure 2 below. In addition, nearly identical scores for the Brief and Total Grit categories provides further support for the Brief Grit metric as a valid predictor of Total Grit. An area of significance to note is that the largest difference between genders occurs in the CoI measurement. One might surmise that females are more likely to stay interested in their major than males which will need to be validated in the next phase of the study.

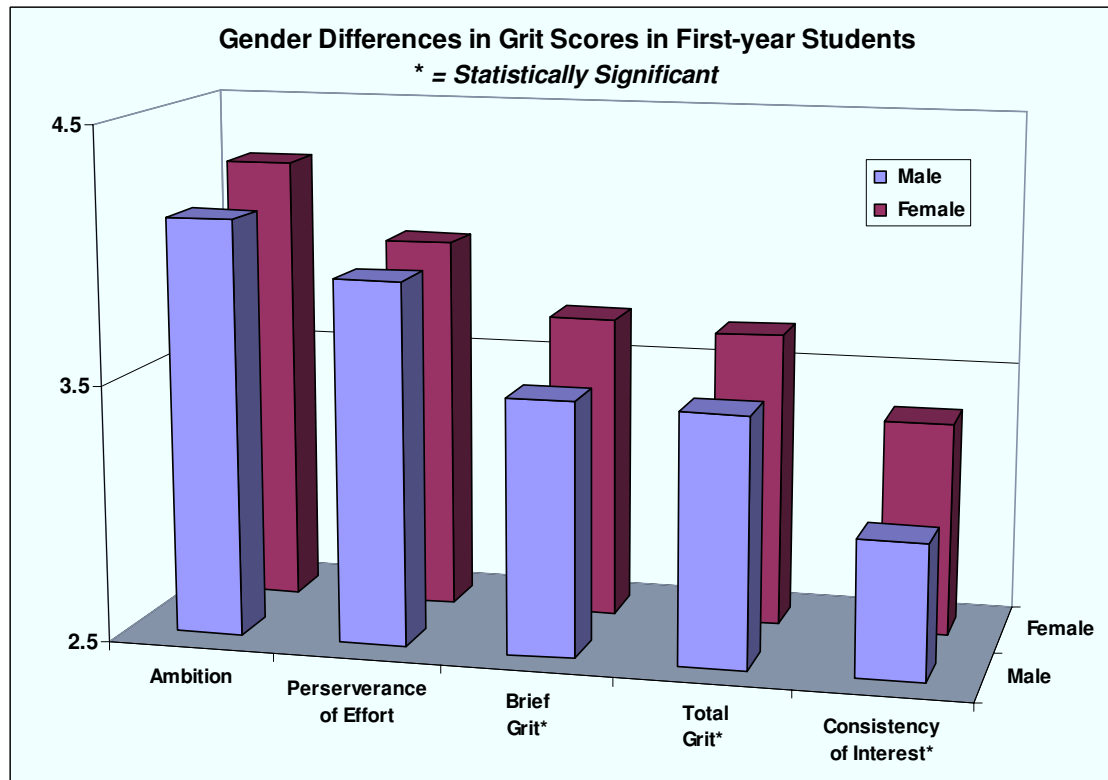


Figure 2. Gender differences in Grit measures for first-year students.

### Age and Academic Level

**Age.** Pearson's product moment correlation found no significant correlation between absolute age and any of the grit scales. This result is reasonable given that the age range is small with our undergraduate sample, there is likely not enough difference in span (17 - 22 years) to show that grit increases with age and experience in our sample. However, a different outcome emerged when the scales were evaluated by class level. Northeastern University is a leader in cooperative education where students alternate semesters of study and full-time employment resulting in five years of classes for almost all students. Figure 3 and Table 2 show the results of evaluating Grit scales across academic levels. Again, evidence is provided for the use of the Brief Grit subscale as a predictor of Total Grit as the two scales follow a nearly identical profile across the academic levels, consistent with the established research in this area.

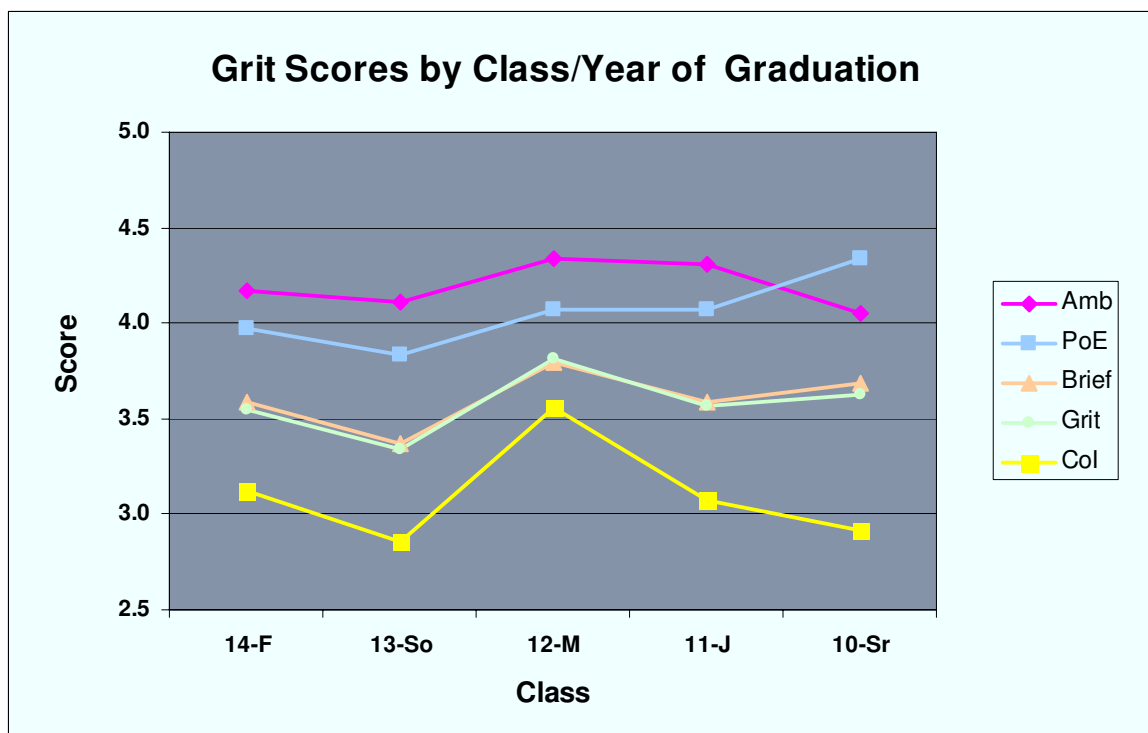


Figure 3. Grit Subscale scores by academic level.

**Seniors.** Among the subscales, there were no significant differences found statistically for the graduation year 2010, the seniors as compared to other academic levels. This is likely because along with a higher level of variability, the sampling size was small for the senior population sampled. We also theorized that Capstone Design exhaustion may factor into the waning ambition—an element to explore beyond this work. As such, that set of pairwise comparisons, graduation year 10, are not included in Table 2.

Table 2. Subscale comparisons by academic level and p-value. Shaded are significant at  $p < .05$ .

Grad. Year	Ambition	PoE	Brief	Total Grit	CoI
14 vs 13	0.23	0.07	0.01	0.01	0.01
14 vs 12	0.16	0.30	0.04	0.04	0.01
13 vs 12	0.11	0.13	0.02	0.00	0.00
14 vs 11	0.08	0.14	0.50	0.40	0.34
13 vs 11	0.05	0.03	0.05	0.03	0.10
12 vs 11	0.44	0.49	0.15	0.08	0.01
14 = First-year, 13= Sophomore, 12=Middler, 11=Junior, 10=Senior					

**Consistency of Interest.** Notably, results show that CoI fluctuates quite significantly throughout the academic journey. This may be attributed to the co-op work experience such that following co-op, students tend to step back and reassess their level of commitment to a particular major, specialty, and/or career path. In essence this is a positive by-product of the co-op program, catalyzing reflection and review in terms of future choices. This is particularly evident as the seniors approach the end of their academic tenure and prepare to graduate. We will be following these results over time and exploring the association with co-op in our ongoing work.

**Brief and Total Grit.** Another fluctuating pattern is the rise and fall of the nearly identical Brief and Total Grit scores and the statistical significance of the score differentials across the academic levels. Across the board, the scores drop between freshman and sophomore year and then rise again in the middler year. It takes perseverance to ‘survive’ the first year in engineering. Possibly, once the routine is mastered with some experience, determination declines somewhat. However, this rebounds in the middler year and remains fairly stable through to graduation.

**Ambition and Persistence of Effort.** The notable factor here is the significant rise of both of these subscales from sophomore to junior year. This is also encouraging as efforts seem to endure as students move through the main portion of the engineering program.

## Engineering Major

Figure 4 plots the grit subscales by major, including the undeclared contingent, which is comprised of first-year students. There were very little differences statistically, except when comparing the high and low values for each subscale.

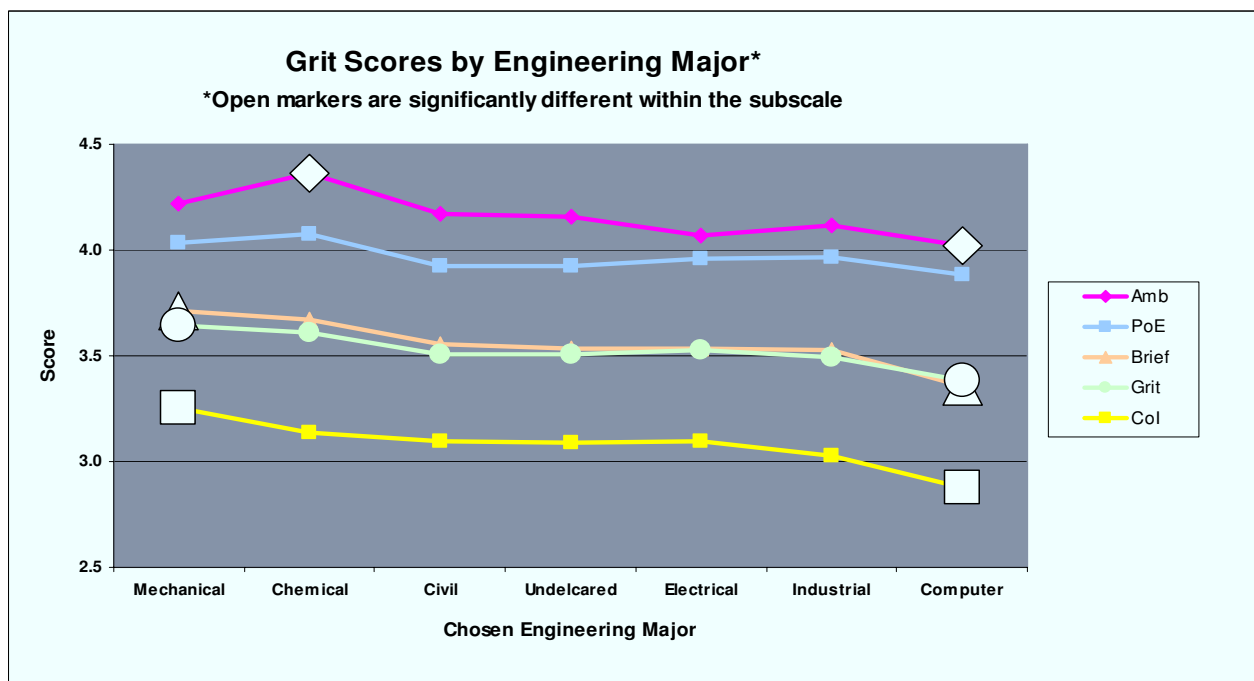
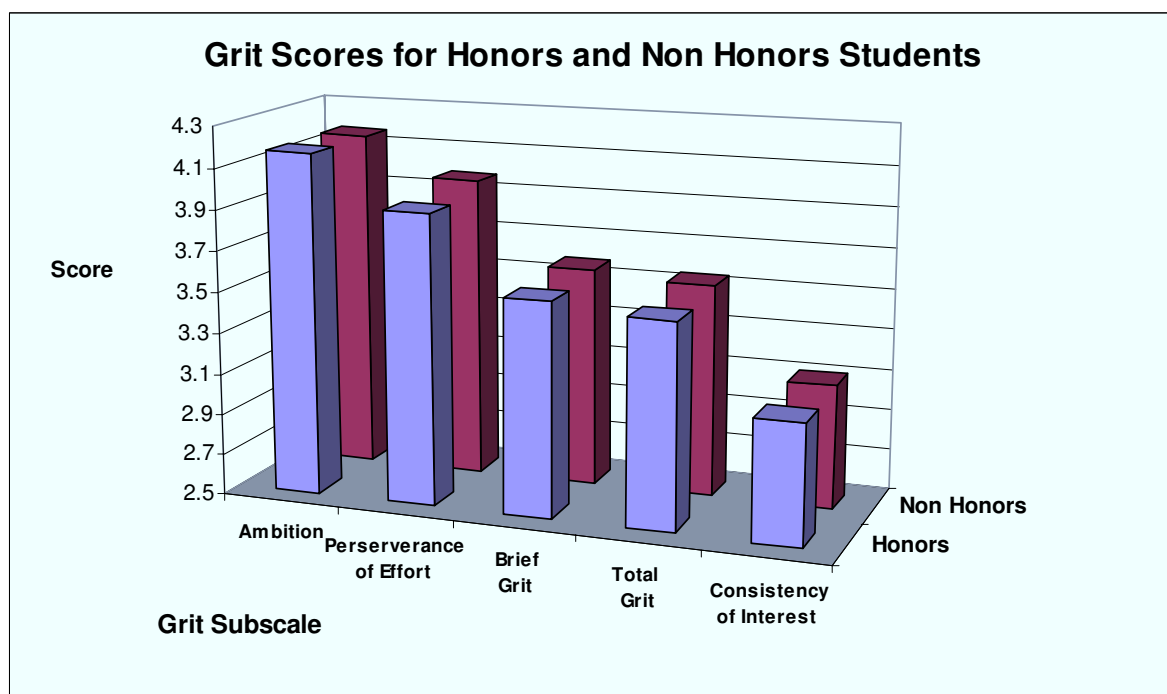


Figure 4. Grit scales by major. Significant differences exist between data sets with open markers

Statistically significant differences were within 4 of the 5 subscales between the highest and lowest measures across the majors. As seen in the figure above, the highest scores were seen in Chemical Engineering and Mechanical Engineering, while Computer Engineering students consistently reported the lowest grit scores across the subscales. Of note is the high value of Ambition for Chemical Engineering as it is perceived on most campuses that it is the “hardest” major in which case would attract those with the most ambition.

## Honors Students

At Northeastern University, students are accepted into the Honors program on the basis of High School GPA and SAT/ACT scores so it was reasonable to explore whether any differences in grit were seen between Honors Students and their Non Honors cohorts. The results for all subscales are presented in Figure 5. It was curious that not only were there no significant difference among honors and Non Honors students, but the trend was that Non Honors students exhibited *more* grit than their Honors Program counterparts. This is not unforeseen since those who have found success in academics to be effortless in relation to their less academically talented peers who have to work hard, simply have not had the need to develop grit.

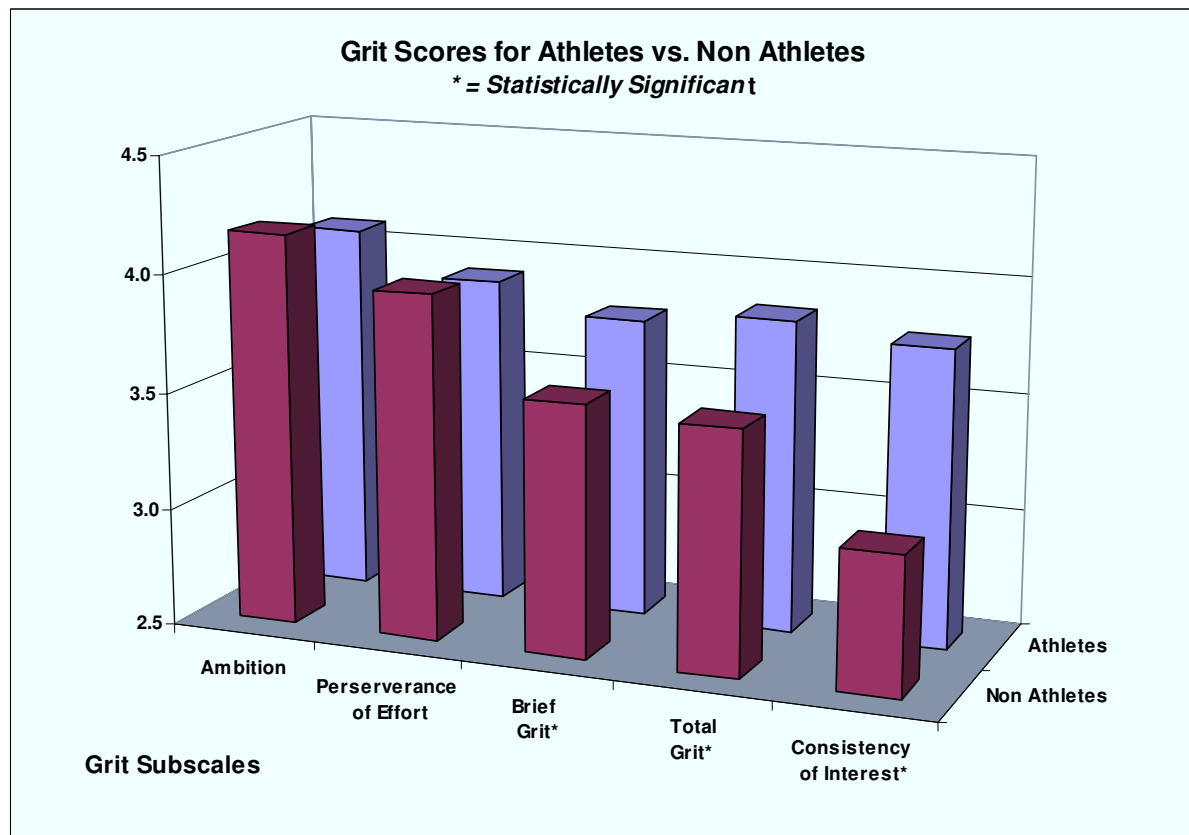


**Figure 5. Grit scores for Honors students versus Non honors students for all subscales.**

## Athletes

The next question we explored was “Do students participating in university athletics exhibit more grit than those not affiliated with an organized sport? As seen in Figure 6, the subscales of Ambition and Perseverance of Effort, which are both strongly related to personal success - especially in academics and career- exhibit no significant differences between the two groups. This is a little surprising. However, athletes demonstrated significantly higher averages for Brief

Grit, Total Grit and Consistency of Interest as compared to their counterparts. This is not surprising as involvement in a team requires discipline, sacrifice, and focus in order to succeed.



**Figure 6. Grit scores for Athletes versus Non Athletes for all subscales.**

## Overview of Results

In reviewing the results pertaining to our students, a few thoughts emerge. It appears that our students, at the outset, have grit levels commensurate with others from previous studies –or slightly higher in some cases. And like other studies have shown, SAT scores and grit levels are not statistically related. At Northeastern University, it is proudly announced that the average SAT scores of admitted engineering freshmen are higher, but this does not necessarily set them up to be a more successful class. Our female students have measurably higher levels of grit; this is supported in previous research, and is not a surprising result for any engineering program, as it would seem that it takes grit to be in field dominated by the opposite gender. (An analogous question to ponder may be; are male nurses grittier than their female counterparts?). Athletes also demonstrated significantly higher averages of grit across selected scales. In engineering, athletes are also a minority, so the combination of demonstrated team attributes (focus, discipline, sacrifice) and a decision to pursue both endeavors in college is undertaken by only a determined few. Anecdotally, we have found athletes to be more organized, mature and very successful in the long term, less distracted than the average first-year student.

Ongoing inquiry into grit as it relates to age and academic level is planned. Currently our smaller upper-level sample sizes and a limited age range might hinder our hunch that as they progress at

the university successfully and complete co-op rotations, grit would increase. The longitudinal work will address the sample size issue as we follow our students into their future majors and years at Northeastern. On subscales though, Ambition and Persistence of Effort do significantly increase, our students become more firmly tied to their majors and career choices, even as courses become harder and jobs may become more challenging. In addition, these results do show the correlated measures of Brief Grit and Total Grit. It is also possible, as was found at West Point surviving “Beast Barracks”, once past the first year, that grit does not change or predict success.

Some unexpected and interesting results arose when we compared the grit scores by engineering major for all first-year students. Mechanical and Chemical Engineers have significantly higher scores than Computer engineers. We might have expected that undeclared majors would be at the lower end, but they are decidedly in the middle. The less determined or less persevering appear to select Computer Engineering, is there something about that major that attracts the less gritty? Or if you are smart and talented, but not necessarily possessing grit, you expect to succeed in that particular field? In following these students, we hope to discover more about these results.

Honors students are not significantly higher in grit; this is partially explainable given that Honors selection is connected to SAT scores and GPA. In light of some of the research on mindset, the non-honors students with grit and a growth mindset may be the most successful. Time will tell. However, perseverance and intelligence combined are a powerful combination, along with many other traits, giving both groups good chances for success.

Reviewing the subgroups and their differences only leads to more questions and a long future in understanding and using these new measures. Our early results have provided us with a great deal of insight, but also continued work.

## **Further Work and Future Goals**

**Effects of Co-op.** Additionally, Northeastern University is a world leader in cooperative education in which students alternate semesters of study and full-time employment. Employment usually begins in the sophomore year. It is not uncommon for a student to struggle through their first year of study and question whether or not they have the toughness to complete the program and become an engineer. It is not until Co-op that they realize that they have what it takes and they can succeed. Do students who have not performed well academically but have proven themselves in the work force possess attributes related to grit such as drive and perseverance? To address this, we need to inquire if any measured increase in grit is due to Co-op rather than academic experiences. We will explore this with more resolution by evaluating upperclassmen that have been on Co-op in order to answer the Co-op related questions. Following Co-op, students will complete a self assessment of work performance along with the Grit survey which may be then correlated to employer performance reviews and academic standing. The Co-op department is working with us to develop the right instruments to administer to the students at the right intervals.

**Following the Students.** We will be tracking this set of students throughout the current academic year to study the relationship between grit and academic success. We will be able to

look at students who leave engineering and their level of grit. This will be done at the end of the first semester and end of the first year. Our hypothesis is that the higher the grit, the higher the chance of success, we expect that those who leave may not be as gritty. We will also review the subscales, such as Ambition and Consistency of Interest. Students have told us they came into engineering because a relative said they should; this lack of personal interest should show.

**Generational Effects.** Are students less gritty now than they were ten years ago? That has been proposed, but there is no way to know. To see trends, we will have to continue to administer this survey as students enter and possibly at another point in their career at this university. Different generations have labels, and attributes associated with those labels –*Baby Boomers, Gen X, Neomillennials*, etc. Will this group’s level of grit be different from that of the next generation?

**Survey Faculty or Alumni.** Another possible avenue of research is to look at groups of a different age and stage in life from Northeastern University. The research done previously would lead us to hypothesize that our Alumni and/or Faculty have significantly higher levels of grit due to age and experience. How do our Alums compare to the Gold standard of West Point? It is also possible that we will be developing our own attributes of productive grit for the long haul as a by-product of this initiative. As we learn more about and understand grit, we may be very inclined to become more focused, more persevering, and attain higher levels of grit ourselves. Faculty, including ourselves may be capable of mindfully cultivating grit internally.

## **Concluding Remarks**

Our hypothesis is that students are better set up for success if they have more grit, more toughness and perseverance. If so, can we as educators influence and increase their grittiness as we teach, coach, and guide them in their first year? What strategies should we employ to foster grit? After all of this, we are only sure that we do not have all of the answers yet. But Carol Dweck and Angela Duckworth both reservedly say that behaviors we as educators promote or discourage can influence our student’s development. Therefore, as a starting point we have become more mindful of the verbal and written feedback we provide.

Since starting this endeavor, we find ourselves dealing differently with our students. We are definitely focused on positive feedback for perseverance, for overcoming setbacks, for showing grit and determination. We are avoiding praise for skill or talent alone. Phrases to avoid include: “Nice job, you really get this stuff” or “Boy, you are really talented at [name it]”. Instead, we are looking for opportunities to say, “Great job getting past that problem, your perseverance really paid off.” or “Wow, that was a challenge, but you did a super job sticking to it and working through the challenges”. We are quick to note that this is not limited to reward for effort alone; rather it takes the form of purposeful praise and incentive for overcoming obstacles that lead to success and achievement. The focus is more on the process required for achieving success and less on having a predetermined set of talents or abilities. To be excited about challenge and to see failure in a positive way is a growth mind-set, one to model and impart to our students. This mindset has the characteristics of grit, of being determined to keep trying even when the going is tough. Just the learning, the interest and the understanding appears to begin the process of change, in ourselves and in how we influence and impact our students. So we start this initiative and this dialog, hopefully with enough grit to keep it going.



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**Appendix A: Grit Survey**  
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*Directions for taking the Grit Scale: Please respond to the following 17 items. Be honest – there are no right or wrong answers!*

1. I aim to be the best in the world at what I do.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
  
2. I have overcome setbacks to conquer an important challenge.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
  
3. New ideas and projects sometimes distract me from previous ones.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
  
4. I am ambitious.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
  
5. My interests change from year to year.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
  
6. Setbacks don't discourage me.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all

7. I have been obsessed with a certain idea or project for a short time but later lost interest.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
8. I am a hard worker.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
9. I often set a goal but later choose to pursue a different one.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
10. I have difficulty maintaining my focus on projects that take more than a few months to complete.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
11. I finish whatever I begin.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
12. Achieving something of lasting importance is the highest goal in life.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
13. I think achievement is overrated.
  - a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all

14. I have achieved a goal that took years of work.
- a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
15. I am driven to succeed.
- a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
16. I become interested in new pursuits every few months.
- a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all
17. I am diligent.
- a. Very much like me
  - b. Mostly like me
  - c. Somewhat like me
  - d. Not much like me
  - e. Not like me at all

## **Appendix B: Grit Subscale Question Associations**

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Directions for scoring the Grit Scale:

- For questions 1, 2, 4, 6, 8, 11, 12, 14, 15, and 17, assign the following points:
  - 5 = Very much like me
  - 4 = Mostly like me
  - 3 = Somewhat like me
  - 2 = Not much at all like me
  - 1 = Not like me at all
  
- For questions 3, 5, 7, 9, 10, 13, and 16, assign the following points:
  - 1 = Very much like me
  - 2 = Mostly like me
  - 3 = Somewhat like me
  - 4 = Not much at all like me
  - 5 = Not like me at all
  
- Total Grit is calculated as the average score for items 2, 3, 5, 6, 7, 8, 9, 10, 11, 14, 16, and 17.
- The Consistency of Interest subscale is calculated as the average score for items 3, 5, 7, 9, 10, and 16.
- The Perseverance of Effort subscale is calculated as the average score for items 2, 6, 8, 11, 14, and 17.
- The Brief Grit Scale score is calculated as the average score for items 3, 6, 7, 8, 9, 10, 11, and 17.
- Ambition is calculated as the average score for items 1, 4, 12, 13, and 15.