Full Paper: Examination of the Development of Grit in First-Year Engineering Students

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Dr. Jenahvive Morgan is the instructor for EGR 100 - Introduction to Engineering Design at Michigan State University. EGR 100 is a large course with an enrollment of over 1600 students in the academic year. She is also currently the Director of Positions for the ASEE Women in Engineering Division, as well as an ASCE ExCEED Fellow. Dr. Morgan has a PhD and MS in Environmental Engineering from the University of Michigan, and a BS in Chemical Engineering from Michigan State University. Her interests include innovative laboratory experiments for undergraduate instruction, engineering design for first-year students, and encouraging women to study engineering. For the three years prior to teaching at Michigan State University, she taught freshman and sophomore engineering courses at Rowan University. While at Rowan University she was Co-Director of RILED (Rowan Instructional Leadership and Educational Development), the advisor for the student chapter of the Society of Women Engineers (SWE), and given the ASEE Campus Representative Outstanding Achievement Award. Her teaching experience also includes work as a graduate student facilitator and engineering teaching consultant at the University of Michigan.
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Introduction

This paper describes a first-year engineering course, and the students’ responses to a grit study. Since this course is a first-year engineering course, and students are faced with difficult decisions during their freshman year, the discussion of grit is pertinent to the experiences that the students are facing. This first-year engineering course is an introduction to engineering design, where students work on interdisciplinary team design projects. There is a lecture and a lab each week, and the lecture topics discuss project management, design and creativity, engineering communication, engineering as a career, ethics, and engineering estimations and calculations with an emphasis on unit conversions. Grit is also a topic covered in the course with reference to the retention of the students in the college of engineering, through to their completion of the engineering degree.

Material pertaining to grit was introduced in the course and then an examination of how this material may have increased student grit was conducted. Duckworth et al. (2007) [1] created a two-factor, twelve item, self-reporting measure of grit. The foundation of this study was based on the theory of grit as a compound trait. This compound trait was comprised of stamina in two dimensions, and these dimensions involve both interest and effort. This study proposed that grit involves the ability to sustain effort and interest in activities which span months or longer to complete, and made a distinction between grit and the need for achievement. Duckworth et al. (2007) [1] identified that individuals with high levels of grit persist in pursuing their goals, despite there being an absence of positive feedback. These traits were found to predict achievement in challenging environments. This perseverance and passion for achieving long-term goals assisted the people who possessed these traits to succeed over and beyond their measures of talent. One example found West Point cadets who were higher in grit were dropping out at a rate less than peers who were not as high in grit. This difference existed even when controlling for high school ranking and SAT scores. The Duckworth et al. (2007) [1] study, along with Duckworth and Quinn (2009) [2] and their examination of a shortened grit scale as an updated version of how grit influences student performance, were the basis of measuring student grit in EGR 100.

Background

Overall, personality factors are important when looking into student performance [3], [4]. A significant part of examining grit as a personality factor is in looking at how students are able to sustain the effort and interest in their long term pursuits over years, even when they face adversity and failure. Despite others giving up and changing course, the gritty student continues on to accomplish their goal. Engagement, meaning, and belonging are found to correlate with grit, and are important in encouraging grit as found in the study performed by Von Culin et al. (2014) [5]. This involves a focus on engaged, sustained effort, instead of short term rewards, and this engagement combined with self-regulation has been found in several studies [4], [7]. Grit has also been found to be predictive of a high grade point average for college students [1].
Commitment, exerting effort in pursuing one’s goals, and performing at high levels have all been shown to be affected by the level of grit found in students [1], [2], [6] - [8]. Grit has also shown to positively influence first year retention. In a study of United States Military cadets at West Point, grit was predictive of first year retention of the cadets by Maddi et al. (2012) [6]. Part of the influence on retention, is that grit is associated with how students respond to adversity or failure. Being able to have a positive response to these situations is important and key to completing long-term goals. Many times grit may be inversely related to student abilities [1]. Therefore, the students who are the most talented, may not be the ones to successfully complete their long-term goals. The students that are used to working hard and overcoming obstacles have shown to become the grittier students. This does not mean that all of the talented lack grit, but instead, that having talent is not predictive of success. Evidence of the necessity of a growth mindset in being gritty was found by Elliott and Dweck (1988) [9] and Murphy and Dweck (2010) [10]. Seeing adversity as a learning opportunity and not just a failure, can determine whether a student is able to sustain their efforts and interest in a long-term goal.

It should also be noted that there are environments that can be detrimental to increasing student grit. Learning environments that are unwelcoming and toxic, can remove the ability of students to sustain the grit that may have been measured previously, as revealed by Inzlicht et al. (2006) [11] and Turner (2015) [12]. The importance of the learning environment is again linked to the student engagement in the community, and the sense of belonging that needs to be acknowledged by the students [13]. Mentorship and having an advocate in the learning environment has been found to be significant in increasing grit in students [12].

Course Framework & Study Description

In EGR 100 students participate in various course activities to encourage the development of grit. Through the lab projects and lecture materials students are exposed to experiences that encourage grit, based on the studies mentioned above, as seen in Figure 1.

<table>
<thead>
<tr>
<th>Development of Grit</th>
<th>EGR 100 Course Activities</th>
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<tbody>
<tr>
<td>Engagement</td>
<td>EGR 100 Lab Projects</td>
</tr>
<tr>
<td>Growth Mindset</td>
<td>Discussion of Duckwork et al. (2007) [1]</td>
</tr>
<tr>
<td>Personality</td>
<td>Myers Briggs Type Indicator (MBTI) Personality Inventory Assessment</td>
</tr>
<tr>
<td>Community</td>
<td>Discussion of MIT Study on Empathy [14]</td>
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Figure 1: EGR 100 course activities that correspond to developing grit based on previous studies

In terms of the material that is covered in lecture, grit is a main topic covered in the course. The study by Duckworth et al. (2007) [1] is presented to the students and a discussion is moderated. Since this course is a first-year engineering course, and students are faced with difficult decisions during their freshman year, the discussion of grit is pertinent to the experiences that the students are facing. Grit as a topic is covered with reference to the retention of the students in the college of engineering, through to their completion of the engineering degree.

In addition to the discussion of grit, students perform a self-assessment of their personality by taking the Myers Briggs Type Indicator (MBTI) personality inventory assessment. This is
discussed as an exercise in self-awareness and how to deal with a variety of personality types. In lecture, the MBTI personality inventory assessment is utilized as a tool to prepare students in navigating miscommunication within their teams, and other proposed difficult situations. How the students communicate and work as a team will determine how well they perform in the course on the two main design projects. These open-ended projects are not the usual academic assignments where one final answer is found. Instead, these projects may have many answers to the problem that is posed, and students will need to be able to face the adversity these difficult challenges create. Many times the first design fails, and several iterations of improving their design solutions will be required to create a successful design. Grit is developed as the students are faced with this adversity, as well as any additional challenges that may arise from dysfunction within their team. The students that persist through these difficult assignments will be developing resilience through successfully completing these ambiguous design projects.

Also covered in lecture, is the study by Engel et al. (2014) [14] from MIT that examines empathy and its influence on successful problem solving. Students learn how best to communicate and be productive in a team, and that this influences their success when solving difficult problems more than the cumulative IQ of the team. This topic is discussed not only in reference to the course, but also in reference to their future career as an engineer.

**Grit Assessment**

To assess the success of the course in improving student grit, a survey was administered before and after course material concerning grit was covered. The course has 655 students and the response rate for the pre-course material survey was 97% or 639 students, and the response rate for the post-course material survey was 93% or 611 students. 152 female students took the pre-course survey, and 145 female students took the post-course survey.

Grit questions were from the short grit scale study performed by Duckworth et al. (2009) [2], which have shown to be successful in estimating grit based on the responses. These questions were used to measure the consistency of interest and effort found in the students. Surveys of the students from the beginning of the semester have revealed that 90% of the female students responded as not being discouraged by setbacks, with 86% of male students having similar responses to the survey, as seen in Figure 2. In contrast, 79% of the male students and 77% of female students identified that new ideas and projects distract them from previous ones. This revealed a grittier response of the students to a question on consistency of effort, as opposed to a question on the consistency of interest.
Figure 2: Male/Female student responses to both a grit effort question and a grit interest question. The students had a grittier response to the effort question than to the interest question.

Again, consistency of interest questions produced less gritty responses from the students. When asked if they have been obsessed with a certain idea or project but later lost interest, 68% of the male students and 62% of the female students had this response. Finally, when asked if they set a goal, but later chose to pursue a different goal, 63% of the male students and 60% of female students had this response. These results can be found in Figure 3. Despite this difference in the consistency of interest and effort, it was identified that the female students consistently had grittier responses than the male students, even if it was only by a small margin.

Figure 3: Male/Female student responses to additional grit interest questions. Female student responses consistently revealed grittier responses.

The results of the preliminary and final surveys were used to better understand the success of the course in increasing student grit. The students who reported a High School GPA below a 3.0 saw the most benefit from the grit material. Of the respondents to the pre-project survey, 80% of
students reported that they often set a goal but later choose a different one. The amount of students reporting this lack of grit decreased to 75%. Additionally, in Table 1, there was also a decrease in the students reporting to have been obsessed with a certain idea only to later lose interest, and an increase in the number of these students who aren’t discouraged by setbacks.

Table 1: Student responses concerning consistency of interest and effort in students with a reported High School GPA below a 3.0.

<table>
<thead>
<tr>
<th>Question</th>
<th>Percent of Students Responding</th>
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<tr>
<td></td>
<td>Pre-Course Material</td>
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<tr>
<td>I Often Set a Goal but Later Choose to Pursue a Different One</td>
<td>80</td>
</tr>
<tr>
<td>Setbacks Don’t Discourage Me</td>
<td>87</td>
</tr>
<tr>
<td>New Ideas and Projects Sometimes Distract Me from Previous Ones</td>
<td>80</td>
</tr>
<tr>
<td>I Have Been Obsessed with a Certain Idea or Project for a Short Time but Later Lost Interest</td>
<td>53</td>
</tr>
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Conclusions

First-year engineering courses are important in providing a foundation of beneficial experiences that will assist the students throughout their academic career. Freshman year is a crucial time in preparing students with the knowledge they will need to continue with their engineering degree to graduation. A significant part of this knowledge base is an understanding of grit and how to develop grit. Understanding the personality traits associated with grit and how to develop a growth mindset around failure, while working in a supportive class environment with engaging projects, provides students with the tools they need to succeed in engineering in college and beyond. The overall reported grit from the students in the course was greater for the female students than for the male students. Also, based on the responses of the students who had a reported high school GPA below a 3.0, the course material on grit assisted these students in becoming less discouraged by setbacks, and less likely to be distracted from pursuing their long-term goals.

References


