Growing Character Strengths Across Boundaries

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Celena Arreola graduated on May 13, 2017 with Bachelors of Science in Engineering Leadership at the University of Texas at El Paso with a concentration in Mathematics and Civil Engineering. Currently she is pursuing a Master of Engineering in Civil & Environmental Engineering and is due to graduate May 2019. She has been actively involved within the Department of Engineering Education & Leadership as a recruitment leader and administrative assistant. Currently she serves as the graduate advisor for the American Society for Engineering Education student chapter and is a research team director in the Center for Research in Engineering and Technology Education where she focuses on the success of students in science, technology, engineering and mathematics of two post-secondary educational institutions based in El Paso.

Mr. Mike Thomas Pitcher, University of Texas, El Paso

Mike Pitcher is the Director of Academic Technologies at the University of Texas at El Paso. He has had experience in learning in both a traditional university program as well as the new online learning model, which he utilizes in his current position consulting with faculty about the design of new learning experiences. His experience in technology and teaching started in 1993 as a student lab technician and has continued to expand and grow over the years, both technically as well as pedagogically. Currently he works in one of the most technically outstanding buildings in the region where he provides support to students, faculty, and staff in implementing technology inside and outside the classroom, researching new engineering education strategies as well as the technologies to support the 21st century classroom (online and face to face). He also has assisted both the campus as well as the local community in developing technology programs that highlight student skills development in ways that engage and attract individuals towards STEAM and STEM fields by showcasing how those skills impact the current project in real-world ways that people can understand and be involved in. As part of a university that is focused on supporting the 21st century student demographic he continues to innovate and research on how we can design new methods of learning to educate both our students and communities on how STEM and STEAM make up a large part of that vision and our future.

Miss Crystal Fernandez-Pena, University of Texas, El Paso
Mrs. Helen Elizabeth Geller, University of Texas, El Paso

Helen Geller is the Program Manager for the STEMGROW grant, funded by the Department of Education at the University of Texas at El Paso.

Ms. Giselle Andrade, STEMGrow
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Diane is a passionate educator and proponent for K-12 engineering education and the education of future teachers. She is a professor in the College of Education at the University of Texas at El Paso (UTEP). She earned her undergraduate and graduate degrees from UTEP and is presently pursuing her doctorate at the University of Southern California (May, 2019).

Hector Erick Lugo Nevarez, University of Texas, El Paso

Mr. Hector Lugo works as a Student Technology Success Coordinator at The University of Texas at El Paso. He holds a B.S. in Electrical Engineering. He is currently enrolled as a Master of Science with a

Major in Electrical Engineering. His motivation and passion pushes him into research in wireless communication, especially in Bluetooth Low Energy and Near Field Communication as well as building projects and fostering innovation with faculty and staff members. As part of the Learning Environments division, the idea to develop, oversee and assess engaging students to expand their knowledge and creativity by innovating new technologies application for Engineering Education is currently under way to engage the university and the community. Concluding, Mr. Lugo's ambition is to encourage students to focus in science, technology and engineer abilities in order to expand their professional potential.

Mr. Pedro Arturo Espinoza, University of Texas, El Paso

Pedro worked in the manufacturing industry as a Quality Control Engineer for some years before acquiring his current position as an Instructional Technologist at the University of Texas at El Paso (UTEP). For over eleven years in this role, he has worked with a team of managers that oversee various learning environments and systems in the Academic Technologies Department at UTEP. He leads a group of more than 30 multidisciplinary student employees that help support a wide range of technologies for classrooms and other learning spaces, including videoconferencing rooms. In addition to teaching a Foundations of Engineering course, Pedro also provides technology training on Mac OS X, CISCO networking and various other technology topics. He also enjoys the role of social media coordinator for Academic Technologies to showcase the department's services and the dedicated students and staff members who work there. Pedro received his Bachelor of Science degree in Electrical Engineering and a Master of Science in Engineering with a concentration in Engineering Education from UTEP.

Mr. Hugo Gomez, University of Texas, El Paso

Mr. Hugo Gomez works as an Instructional Technologist at the University of Texas at El Paso, he is focused on expanding the professional and technical skill sets of our students and faculty community to better prepare them for the world of technology today and tomorrow. He works alongside a wide assortment of students, faculty and staff on campus to make sure their technology toolsets are up to date. Furthermore, Hugo provides workshops to over half of the student population at UTEP and as such, has been instrumental in providing the behind the scenes support to all these courses. Mr. Gomez also collaborates in the Learning Lab team to explore and implement new educational strategies in the classroom. Mr. Gomez has a Masters Degree in Engineering Education from The University of Texas at El Paso. He has participated in the UTEACH summer program as a Technology Instructor in which he provided workshops on website design, movie creation and computer networking. In addition, Mr. Gomez teaches UNIV1301 Foundations of Engineering, were students learn academic, personal and engineering skills, among many other abilities that help them understand their opportunities and responsibilities as engineering students.

Mrs. Herminia Hemmitt, University of Texas, El Paso

Mrs. Herminia Hemmitt is part of the Learning Environments team in Academic Technologies at The University of Texas at El Paso. She is responsible for coordinating classroom technology upgrades and implementations to ensure project deadlines and anticipated goals are met. Her educational background in organizational and corporate communication is utilized in consultations with faculty and staff about their learning environments in order to correctly match them to appropriate learning spaces or adapt existing spaces to meet their pedagogical and technological needs. Her focus is on the specific user to make sure that classroom needs, technical needs, and/or event needs are met.

Ms. Melissa Stearns

Work in Progress: Growing Character Strengths Across Boundaries

Abstract

Creating a community of purpose amongst engineering students is helpful in guiding their successful transition from high school to higher education learning environments. In such learning environments, the capacity to studiously pursue long-term goals can be a defining characteristic of successful students. Duckworth and associates refer to this as the "tendency to sustain interest in and effort towards very long-term goals" [1]. In this paper, we will discuss the work we are currently doing to develop strength in character for our students.

First, it is important to understand the word 'grit' as one that encompasses traits we wish for our students to build upon. Essentially, to have grit implies having a trait-level perseverance, resilience, and passion for achieving long-term goals; all attributes which are recognized as important to the retention and graduation of first-generation university students. We are currently fostering the development of grittiness in students at two interconnected institutions of higher learning: El Paso Community College (EPCC) and The University of Texas at El Paso (UTEP). Using online tools to support self-awareness, we monitor their progress as they begin to cross behavioral boundaries.

We will also extensively discuss EduGuide [2], an online toolset that incorporates a series of life lessons which we use to investigate how effectively we can impress upon students the benefits of growing grittiness. The discussion will center on EduGuide's features, accessibility, and reported effectiveness.

Introduction

The research of Angela Lee Duckworth that culminated in her New York bestseller *Grit: The Power of Passion and Perseverance* [1] brings forth two big ideas: first, that grit (comprised of a person's perseverance and passion) can be among the most important predictors of success, and; second, that one's grit can indeed be self-developed. The popularity of these ideas has

encouraged a conflagration of efforts to incorporate and integrate grit into every facet of the education system, from curriculum development to personal and professional development.

As posited by Duckworth, the higher one's grit level, the more likely they are to have a corollary trait of "self-regulation," which, in tandem with grit, leads to academic achievement or success. She further defines self-regulation as "the voluntary regulation of behavioral, emotional, and intentional impulses in the presence of momentarily gratifying temptations or diversions" [3]. While Duckworth offers approaches to fostering grit at school, home, and in the workplace, she does admit to a lack of solid research in the art of growing grit. Though, it is not our purpose to definitively review the literature of grit; rather, we endeavor to grow character development amongst STEM students. In fact, this is one of the valuable goals of our UTEP STEMGrow Program [4], a partnership with EPCC that focuses on achieving the next generation of engaged and professional students.

Our studies at EPCC and at UTEP (both notably Hispanic-serving institutions) are enabling us to learn of the outcomes when science and engineering students are provided access and support for building positive habits through the use technology-based tools of engagement. Testing the impact of mentoring strategies helps us to further guide our efforts, and provide accessible and responsive coaching and mentoring that is self-paced and reaches beyond the classroom. Through this partnered project, we share the results of implementation on multiple sections of entering and first-year student courses, and the initial conclusions of the work provide a basis for future efforts in all entering student courses in biology and engineering.

Growing Character: Willpower, Self-Control and Grittiness

The study of character development is indeed a work in progress. Recently, the work of Sisk, Burgoyne, Sun Butler and Macnamara [5], whose meta-analyses examined the effectiveness of mind-set interventions on academic achievement and potential moderating factors, found overall effects were weak. However, some results supported specific tenets of theories that suggest students with low socioeconomic status or who are academically at risk might benefit from mind-set interventions.

Simultaneously, the emergence of grit has seen a significant renaissance, most recently as a key component of success in not just Hispanic, but in all students' lives. According to Duckworth, this is especially significant in a recent culture that is "getting soft" [1]. Thaler and Koval [6] underscore grit as fundamental to "perseverance, passion, and pluck" in taking one from ordinary to the extraordinary [6]. They define character development through grit as:

> "Grit is about sweat, not swagger. Character, not charisma. Grit has been equated more with methodical stick-to-itiveness and survival than any secret ingredient to success. Which is too bad, because for so many, grit is the secret to success. Grit is the result of a hard-fought struggle, a willingness to take risks, a strong sense of determination, working relentlessly toward a goal, taking challenges in stride, and having the passion and perseverance to accomplish difficult things, even if you are wallowing in the most difficult circumstances" [6].

Duckworth and Gross [7] recognize self-control and grit as two related but separable determinants of success. When studying why some people are more successful that others, talent and opportunity are often cited; however, it can be argued that what is truly lacking is an integrative framework for understanding the requirements that influence different kinds of success regardless of talent or opportunity. Hence Duckworth and Gross' two related determinants of success: self-control and grit. To better understand their similarities and differences, they employ a theoretical framework of goal hierarchy, drawing on contemporary goal theory. They suggest that understanding how goals are hierarchically organized clarifies how self-control and grit are related, yet distinct.

While not explicitly defined, Duckworth and Gross effectively use this hierarchical goal framework to introduce how self-control predicts many consequential outcomes, in addition to other factors such as general intelligence or socioeconomic status. They refer to this as 'willpower', and address the psychological processes that underlie self-control. Likewise, they apply this framework to grit, predicting the completion of challenging goals despite potential obstacles or setbacks. Within this theoretical goal framework, 'self-control' refers to the

successful resolution of a conflict between two action impulses. Using the same hierarchical goal framework, grit entails having a dominant super-ordinate goal that is pursued with passion and perseverance over many years. The distinction of self-control is coupled with everyday success, whereas grit is coupled with exceptional achievement over a much longer period of time. They argue that this framework approach advances the understanding of the related yet distinct psychological mechanisms that underlie these two determinants of success.

EduGuide: Cloud-based App Targeting STEM Mentoring

EduGuide is an online toolset that incorporates a series of life lessons which we use to investigate how effectively we can impress upon students the benefits of growing grittiness. Our findings to date clearly show that impacting students to the point of causing change does not come easily and requires a dedicated investment of time, attention, energy, and effort. This is especially true for students studying engineering, biology, math, and other sciences that are generally perceived to be more time consuming and/or labor intensive. For our initial cohort of students, we used a validated science motivation assessment [8], and found that they did experience an improvement in their grit levels; however, we lacked an adequate experimental control group. Thus, further experiments are needed to improve and advance our understanding of the true impact of the use of EduGuide systems.

As a key component of our work in STEMGROW [4], this technology-driven application is an evidence-based online training program aimed at strengthening non-cognitive, core learning skills for students from middle schools to college grade level. It is introduced as a communications mechanism to facilitate mentoring and grow student awareness and mindset. Supported by Duckworth's research, EduGuide [2] asserts that:

> "A student's level of grit — the measurable ability to focus on long term goals and overcome obstacles along the way — is a better predictor of success in school and careers than IQ."

EduGuide is a comprehensive nonprofit program that includes:

- A web-based app students and staff can use on any phone, tablet or computer
- A systematic student curriculum
- Blended offline support materials and group activity options

- A parallel series of self-paced professional development activities that can be done individually or collaboratively
- An online and on-call technical support system
- Reporting and analytics tools
- An assigned results coach to help your institution continually improve impact.

As part of the work in progress we have built and piloted, we are continuing to expand. If the effort is impactful, then we will institute systemic, targeted, STEM guidance and mentoring. We are conducting STEM-themed sections of gateway introductory engineering courses through a partnership with EduGuide [2], and the Lumina Foundation 's National Tech Challenge selected EduGuide's intervention as a model for making college access and success more efficient. They have supported EduGuide with a planning grant to further test and refine the platform, as has the W.K. Kellogg Foundation to help scale-up EduGuide's platform and program.

Assessment of Grit Levels of Participating Students

Overall, 108 freshman-year STEM students participated in the baseline assessment of students' grit levels in early fall 2017. Of the 108 students, 81 were STEMGrow students, while 27 were non-STEMGrow students (Control Group). The first post-assessment involved 64 students, 43 of whom were STEMGrow students, and 21 were non-STEMGrow students. A total of 38 students, 26 STEMGrow and 12 Non-STEMGrow students participated in both assessments and therefore had both pre-test and post-test Short Grit Scale scores [4], [9]. The maximum score on the Grit Scale is 5 (extremely gritty), while the lowest score is 1 (not at all gritty). The results of the assessment can be seen in the table below:

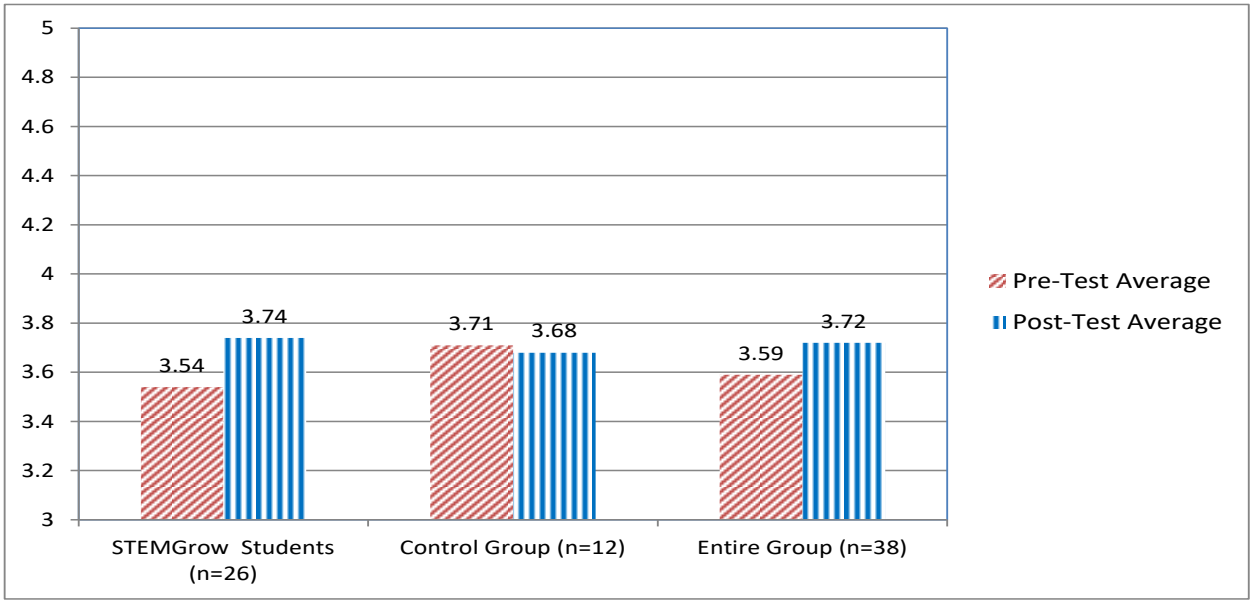

Figure 1. Changes in Student Grit Levels (Fall 2017)

Academic success does not necessarily come easily for many of our engineering students. As stated previously, to be successful requires a dedicated investment of time, attention, energy, and effort. A great deal of self-regulation is also involved, which Duckworth defines as "the voluntary regulation of behavioral, emotional, and attentional impulses in the presence of momentarily gratifying temptations or diversions" [3].

As shown in Figure 1, the initial cohort of STEMGrow students appear to have experienced improvements in their grit levels, rising from 3.54 to 3.74 during their first semester in the program (2017 Fall Semester). Meanwhile, their non-program peers suffered a decline from 3.71 – 3.68.

Assessment of Science Motivation Levels of Participating Students

The Science Motivation Questionnaire II [8] was used to assess the motivation levels of students involved in the program, via a convenience sample of STEM students who attended the same STEM classes at UTEP and EPCC in Fall 2017. The pre-test assessment was conducted in early Fall, while the first post-test assessment was conducted at the end of the Fall semester. The Science Motivation Questionnaire II (SMQ-II) instrument produces: 1) five subscale scores, one

for each of the five major factors (0 – 20 per subscale) or components that determine the overall science motivation levels of students; and 2) one aggregate score (0 – 100). The five subscales are: Intrinsic Motivation, Self-Efficacy, Self-Determination, Grade Motivation, and Career Motivation. Glynn and his associates define student motivation to learn science as the "internal state that arouses, directs, and sustains student behaviors associated with the learning of science [8].

Table 1. Student Scores on the SMQ II-Pre & Post Tests

Test	Students/Scores	Intrinsic Motivation	Self-Efficacy	Self-Determination	Grade Motivation	Career Motivation	Overall/Raw Aggregate
Pre	Total #	114	114	114	114	114	
	Average Score (n=114)	14.25	14.23	13.64	16.92	15.35	**74.39**
	STEMGrow(n=86) Score	14.63	14.16	13.85	16.81	16.0	**75.45**
	Control (n=28) Score	13.11	14.43	13.0	17.25	13.36	**71.14**
Post	Total #	60	60	60	60	60	
	Average Score (n=60)	15.25	15.02	14.2	16.67	15.7	**76.83**
	STEMGrow (n=50) Score	15.72	14.88	14.44	16.64	16.2	**77.88**
	Control (n=10) Score	12.9	15.7	13.0	16.8	13.2	**71.6**

While Table 1 shows the science motivation characteristics of students who participated in only or both the pre-test and post-test assessments, Table 2 shows the changes in science motivation levels of students who participated in both assessments.

Table 2. Students with Both SMQ II-Pre & Post Tests

Test	Students/Scores	Intrinsic Motivation	Self-Efficacy	Self-Determination	Grade Motivation	Career Motivation	Overall/ Raw Aggregate
Pre	Total # (n=37)	37	37	37	37	37	
	Average Score (n=37)	14.08	13.68	13.41	16.68	14.92	**72.76**
	STEMGrow (n=27) Score	14.78	13.81	14.1	17.0	15.7	**75.41**
	Control Grp.Score (n=10)	12.2	13.3	11.5	15.8	12.8	**65.6**
Post	Total # (n=37)	37	37	37	37	37	
	Average Score (n=37)	14.49	14.38	13.46	16.41	15.35	**74.08**
	STEMGrow (n=27) Score	15.37	14.48	14.26	16.63	16.41	**77.15**
	Control Score (n=10)	12.1	14.1	11.3	15.8	12.25	**65.8**

The following Figures (Figures 2 - 4), based on Table 4, show the improvements in the Science Motivation levels of the STEMGrow students, after a full semester's exposure to STEMGrow activities, instruction, and resources. As shown in Figure 2, STEMGrow cohort students improved their overall motivation to learn science, from a baseline of 75.4 to a 77.2 (a gain of 1.8 units). This gain in SMQ-II motivation units compares to 0.2 gains (65.6 to 65.8) by their non STEMGrow peers.

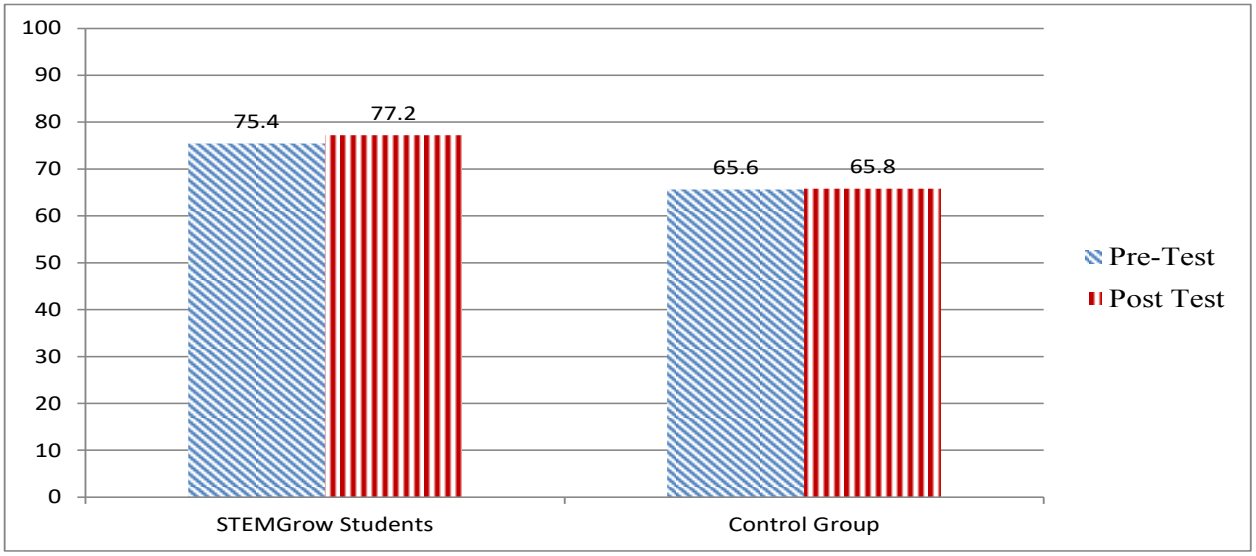

Figure 2. Overall Aggregate Raw Score of Science Motivation Levels (Score Range: 0-100)

As shown in Figure 3, the STEMGrow students experienced improvements in the following four out of five Science Motivation sub-scales/components (Scale: 0-20): Career Motivation, Self-Determination, Self-Efficacy, and Intrinsic Motivation. Although the Grade Motivation level of the STEMGrow students experienced a slight decline from 17 – 16.6, the level continued to be the highest of the five components, on both the pretest assessment and post-test assessment.

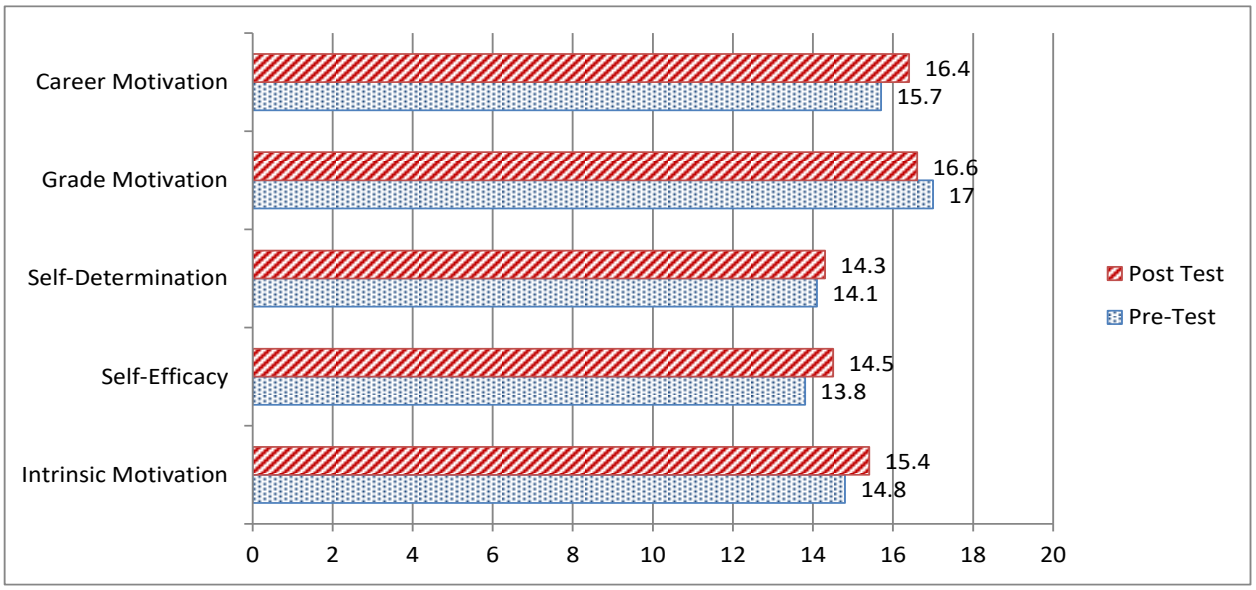

Figure 3. Changes in STEMGrow Students' Science Motivation Levels:Five Motivation Components (Score Range: 0-20)

As shown in Figure 4, while the STEMGrow students' Science Motivation component scores/levels above 15 (Scale 0 – 20) on the pre-test were Grade Motivation (17) and Career Motivation (15.7) while those of the post-test were Grade Motivation (16.6), Career Motivation, and Intrinsic Motivation (15.4). The Non-STEMGrow students' highest and only component with a score at 15 or higher on the pre-test and post-test was Grade Motivation (15.8 on both tests). Overall, the subscales scores of the STEMGrow students were higher than those of their Non-STEMGrow peers, on both the pre-test and post-test.

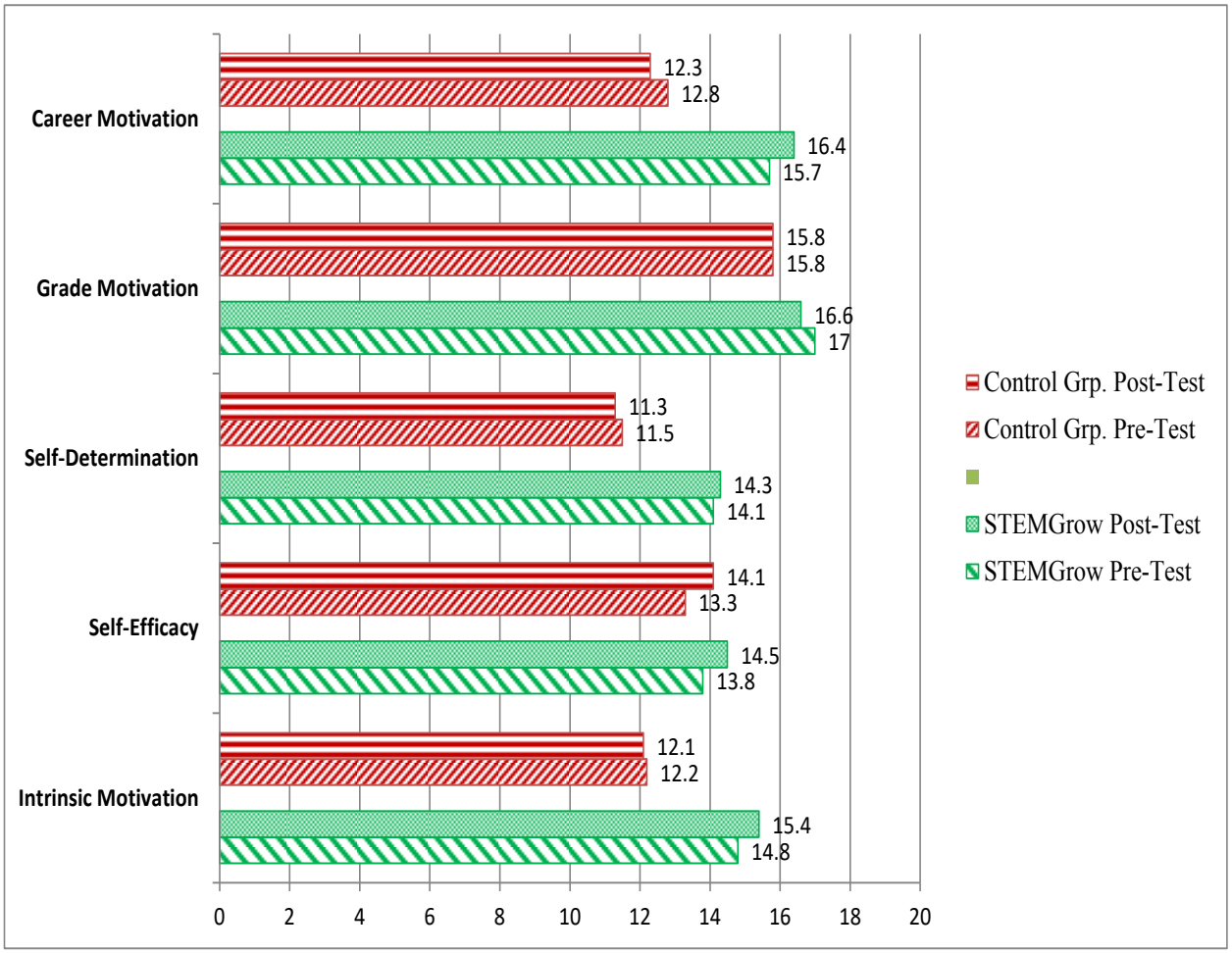

Figure 4. Changes in STEMGrow and Control Group Students' Science Motivation Levels: Five Motivation Components (Score Range: 0-20)

Program Students' Perceptions of EduGuide Impact

The EduGuide is a major sub-component of the STEMGrow program. Through the implementation of research-based activities, services, and resources, EduGuide seeks to develop the mind-set, confidence, knowledge, skills, resilience, and self-control of students. Additionally, EduGuide attempts to enhance personal development and students' understanding of the college culture, while learning what it takes to succeed in college. The data for this section of this report was collected through a survey at the end of the 2017 Fall semester.

Table 3 provides the summary of responses from the STEMGrow students regarding the list of 14 growth areas and the following survey question: *"So far, how have you grown through the work you've done with EduGuide?*

Table 3. Perceived Growth Attributed to EduGuide

Growth Areas	**No Growth**	**Little/ Slight Growth**	**Moderate Growth**	**Considerable Growth**	**Significant (Very Considerable) Growth**
1. More self-motivated	2%	17%	43%	**29%**	**10%**
2. Better grades	21%	21%	29%	**26%**	**2%**
3. Enjoy learning more	12%	21%	29%	**31%**	**7%**
4. More prepared for class	14%	17%	33%	**24%**	**12%**
5. Participate more in class	19%	19%	24%	**36%**	**10%**
6. Complete more schoolwork	12%	19%	18%	**12%**	**4%**
7. Listen better to feedback	7%	21%	26%	**33%**	**12%**
8. More curious to learn new things	12%	17%	24%	**21%**	**26%**
9. Better attendance	24%	19%	14%	**29%**	**14%**
10. Improved relationships	19%	10%	29%	**33%**	**10%**
11. Encourage and mentor others more	12%	12%	33%	**29%**	**14%**
12. Manage stress better	14%	17%	31%	**29%**	**10%**
13. Get over setbacks quicker	12%	12%	31%	**36%**	**10%**
14. Happier	21%	14%	21%	**24%**	**19%**

In highlighting the significant impact of EduGuide on the STEMGrow students, the proportions in the last two columns of Table 3 were combined and presented in Table 4, as well as graphically presented in Figures 5 – 18. While the lowest percentage of the participating students indicating they had experienced *Considerable or Very Considerable* growth was 29% (enabling them to achieve *Better Grades*), the highest percentage of the participating students indicating they had experienced *Considerable or Very Considerable* growth at 47% (enabling them to be *More Curious to Learn New Things*) On average, 41% of the students indicated they had experienced growth in the 14 growth areas that are associated with learning success in college.

Among the growth areas with higher than 41% of the students attributing growth to EduGuide are the following: Better Attendance (43%); Improved Relationships (43%); Encourage and Mentor Others more (43%); Happier (43); Complete more Schoolwork (46%); Listen Better to Feedback (46%); Get over Setbacks Quicker (46%); and More Curious to Learn New Things (47%).

Table 4. Perceived Growth Attributed to EduGuide (Simplified Table)

Areas of Impact	**No Growth**	**Little/Slight Growth**	**Moderate Growth**	**Considerable/Very Considerable Growth**
1. More Self-motivated	2%	16%	43%	**39%**
2. Better Grades	21%	21%	29%	**29%**
3. Enjoy Learning more	12%	21%	29%	**38%**
4. More Prepared for Class	14%	17%	33%	**36%**
5. Participate more in Class	19%	19%	31%	**31%**
6. Complete more Schoolwork	11%	19%	24%	**46%**
7. Listen Better to Feedback	7%	21%	26%	**46%**
8. More Curious to Learn New Things	12%	17%	24%	**47%**
9. Better Attendance	24%	19%	14%	**43%**
10. Improved Relationships	18%	10%	29%	**43%**
11. Encourage and Mentor Others more	12%	12%	33%	**43%**
12. Manage Stress Better	13%	17%	31%	**39%**
13. Get over Setbacks Quicker	11%	12%	31%	**46%**
14. Happier	21%	14%	22%	**43%**

Student Comments

In support of the preceding perceptual assessments, the following STEMGrow student responses are offered:

Question: In your own words, how has your work with EduGuide helped you so far this year?

- "I learned many new things and strive better."
- "(I learned) to be a better problem solver."
- "I have actually mentored a cousin of mine not because I am a good role model but because I know how not to be like me and that sometimes seems to be a better way of life."
- "I've learned a lot about myself, about how people have mentored me, how I learn things, and how I can change my mind from a fixed mindset to a growth mindset. I have also learned about how to be a good mentor to others, how to give and receive effective encouragement."
- "It has helped me to realize that anyone can do or become anything, all we need is more commitment."
- "It has improved the way I see my career. It helped me to know that I actually want to do and what my career is."
- "I feel like I can manage my time better and it made me realize how I can grow as a person every day with small actions."
- "I am more open to constructive criticism and I manage my time and stress better than I did before. I am also more confident in approaching people."
- "(It has) helped me stay motivated and focused on what is important."
- "I've learned to better cope with situations and not become as stressed."
- "EduGuide helped me to learn how to concentrate."
- "More positive about things and better relationships."
- "I learned how to keep encouraging myself and others like my friend especially my family."
- "It has helped me personally with relationships with family and friends as well as improvement on my school work."

- “It helped me stay on track.”
- “It helped me to reflect on what I have overcome. It has also motivated me to keep trying and help others along the way.”
- “(It) helps keep a positive mindset.”
- “I have been more conscious on what I want to do, on what I do and what I don't do. This has helped me improve in my personal and professional aspects.”
- “I feel like I have gotten a bit more motivated especially when times got rough. Also, I feel impatient almost to just getting started on my career path.”
- “It has helped me to improve my relationship with my mother.”
- “This semester I started using EduGuide and I think it motivated me to try and find more people to support and help through their hard times, try and make more friends and have a better relationship with my mother. In general I don't feel a lot of change because I have always been curious and enjoy learning new things, also always have been good in school with respect to grades and school work.”
- “Basically EduGuide did help me, but just in the relationships part.”
- “It taught me things that I didn’t know about.”
- “It has made me more prepared to tackle learning obstacles. It also has made me reflect on my own struggles that have been holding me back.”
- “I have improved by not focusing on setbacks.”
- “It has helped me do better in school and life.”
- “I did not use it as much as I should although in the beginning of the semester it inspired and gave me hope to make it past the semester.”
- “It reminded me to slow down and reflect on my own life, and it has even encouraged me to write in a journal. It helped me to take my own advice and to practice what you preach.”
- “Overall, I liked EduGuide and how it encouraged me to better myself.”
- “I have become more optimistic.”
- “(It has) motivated me to work harder for what I want.”
- “It has made me realize how many obstacles I've been able to get through by myself, and that nothing can stop me from reaching my goals.”

- “I have grown in overcoming setbacks quicker.”
- “It has helped me to keep track of things that need to be done and offered help to me if I've ever needed it.”
- “It has helped me understand how to deal with relationships with people and along with learning more about what I'm capable of.”

Discussion of Work in Progress Results

While the positive findings in the first two sections of this report may not initially be directly attributed to the STEMGrow program (due to the lack of an adequate experimental control group), the perceptual assessments of the impacts of the EduGuide program lend a triangulated support to the improvements in STEMGrow students’ grit and motivation levels, which can be attributable to the STEMGrow program. The degree to which the STEMGrow cohort students perceived their significant growth in 14 vital areas directly and empirically associated with academic achievement and college success is a major finding. The assessments offer a compelling insight to the pervasive impact of EduGuide strategies, activities, and resources in enhancing the comprehensive academic readiness of students (especially amongst minority students with little or no history of college attendance and completions).

Further Developing, Testing and Using “EduGuidance

EduGuide may provide a sustainable model to increase Latino student persistence in STEM fields by embedding evidence-based noncognitive activities and mentoring support in STEM courses as a transition bridge. EduGuide will serve as a catalytic platform to surround students with social capital as they are mentored by faculty, support staff, alumni and employers who will guide them through the completion of their degrees and entering the workforce. This will provide a collaborative model that can be easily scaled and replicated to enlarge the impact of existing student success programs at a lower cost.

Significant results on a nationwide scale can be expected to be produced from our project. EduGuide’s evidence-based online program builds grit and other non-cognitive skills critical for

first generation students on the path to a college degree. Moreover, the impacts of the skills they learn go far beyond the classroom, preparing STEM students for the many life challenges they face on the path to a college degree [11]. It is also important to note that in these studies, improvements in students' GPA have been shown at both the secondary and post-secondary level, with the most consistent gains made by lower-income, first-generation and minority students.

EduGuide activities are consistently delivered to every student in the same fashion, every time. Once a week on average (as part of a class), students simply utilize a mobile device (a phone or tablet, for example) for 15-plus minutes, during which they engage in an evidence-based activity designed to shape mindsets, build skills and shift academic behaviors. Later that day or week, their teacher (or other STEMGROW "EduGuides;" faculty, staff and peer guides) provides brief mentoring responses to their activities, meant to engage students in additional writing and reflection.

A 2016-2017 student survey revealed the following top impact areas, based on 473 student responses [4], to show growth or positive impact:

- "More self-motivated" (73%)
- "More confident to achieve: (68%)
- "More curious to learn new things" (66%)
- "Listen better to feedback" (65%)
- "Encourage and mentor others" (63%)

In our EPCC and UTEP incarnation of the EduGuide process, students are tasked to use SMART technology online activities for up to one hour per week outside of the classroom (for which they typically will receive some course credit) to help them engage, interact, grow, and persist in their learning. EduGuide students work with teachers and fellow undergraduate/graduate student mentors via a virtual, asynchronous web-based application platform; this encourages them to develop their sense of purpose and passion, forge stronger bonds, and that make it easier for them to learn, explore, develop, and plan for success. The EduGuide's will also continue to be

an asset for STEMGrow to facilitate, structure, and expand the community mentor's influence in reaching out to more Hispanic students.

Lastly, using the EduGuide online system of engagement, and learning from student feedback about the impact allows us to prepare data on the controversy addressing the use of 'grit' in the social emotional learning in education, and whether or not grit can be developed and be measured.

Relation to Other Work on Growing Character

Bottomley [12] studied the grittiness of incoming engineering students at NC State University using Duckworth, Peterson, Mathews and Kelly's [3] grit assessment. The NC State University assessments parallel those of Duckworth, Peterson, Matthews and Kelly [3], as well as those of and Duckworth and Quinn [9] whose results we report. Notable differences in the NC State University Grit-S measurement were in relation to gender and ethnicity (in the first cohort of 375 first-year engineering students Bottomley surveyed). If similar behaviors are detected in future cohorts, Bottomley hopes to gather data (through focus groups, for example) that might derive explanations for the findings. Bottomley concluded:

> "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."

By contrast, Williamson, Pannizo, Perriakos and Anderson [12] utilized the Benson's model of construct validation in the development of the Engineering Student's Motivational Beliefs Scale. They point out a caveat that we need to examine:

> "A major limitation is that the students who chose to participate in this study may not be representative of all engineering students. These students may be more engaged and motivated within the major, as shown by their desire to volunteer for this study."

Also, the university at which the study was conducted has a unique general engineering program, one in which students do not declare a specific discipline within engineering but are instead encouraged to explore different disciplines. In the future, Williamson and colleagues suggest a different measure of student engagement may be used to see if these relationships hold true.

Senkpeil and Burger [13] showed that a combination of cognitive and non-cognitive factors lead to a significantly more predictive model of first-year engineering GPA than cognitive factors alone. In addition, they showed that for a sample of academically high performing applicants, cognitive factors alone do a poor job of predicting first-year engineering performance. A potential implication of this result is that students' first-year performance is more than simply a function of their past performance; rather, non-cognitive factors such as test anxiety and conscientiousness provide very important information as to how well students are likely to perform. Perhaps even more important than improved predictability, according to Senkpeil and Burger, is the fact that many non-cognitive factors are malleable. Thus, changes in non-cognitive factors can lead to a non-trivial increase in student GPA. These results also lead into an interesting discussion about interventions:

> "Changing students' non-cognitive profiles can lead to noticeable changes in their academic performance. However, we have also shown that students' non-cognitive factors impact their academic performance in different ways depending on the context. Therefore, we would not expect large scale, highly structured interventions to have a distinct impact. ….. From these results it seems that non-cognitive interventions are a viable way to improve student academic performance, but they need to be tailored to individual classes, or better yet individual students, to account for differences in both non-cognitive attributes and academic context."

Final Remarks

It is important to keep in mind that growing character traits, including grittiness, is hardly a new concept; in fact, it is an old one. Employing longitudinal discourse analysis, Ris [14] examines the history of grit over more than a century, paying special attention to the ways in which adults have attempted to inculcate it in children. Ris finds that:

> "Current discussion of grit's salience for the education of disadvantaged students ignores the rich historical context of a long-sought trait, which in fact has usually been the focus of anxiety from middle and upper-class parents and educators. Grit functions as a proxy for a type of character-building that privilege prevents. When poor children have appeared in this discourse, they are not the problem but rather the romanticized solution. A similar pattern is emerging today."

To conclude, the role of character building in education is one that we recognize as fundamental to student success, not only for those within STEM fields but across all majors and disciplines. Additional research and assessments are needed to ensure the best possible practices are being utilized. Finally, we will continue to seek out new opportunities and methods that will enable us to achieve our goal of developing and graduating more passionate, resilient, and prepared students.

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