Time to Quit with Grit? Expanding the Academic Persistence Framework

by

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Abstract

Examinations into the effect of motivation and ability on academic and workplace performance have been fluid in the past century. Current operationalizations have proposed grit—defined as perseverance and passion in pursuit of long-term goals—as the primary measure of motivation. Drawing upon Expectancy-Value Theory, the current study examined whether academic resilience outperformed grit as a predictor of performance in the context of a business analytics course. Both constructs demonstrated similar predictive ability, though neither outperformed previously-established constructs. However, grit and academic resilience each significantly moderated the relationship between a student's magnitude of failure and their subsequent performance on the final exam, such that continued failure was only observed for students low in either trait. Implications for the use of specific motivation-based predictors are discussed.

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GPA   Grade Point Average (4.0 scale)

STEM   Science, Technology, Engineering, & Math

SDT   Self-Determination Theory

IM-K   Intrinsic motivation to know

IM-A   Intrinsic motivation to accomplish

ARS-30   Academic Resilience Scale

Grit-S   Short Grit Scale

MoF   Magnitude of Failure

The debate over whether success is derived from innate ability or expenditure of effort is a longstanding one. Identifying the source of success possesses implications for both academic and workplace settings, particularly for recruitment and selection. For example, the current college admission process seems to imply the former: standardized testing is considered to be a reliable measure of students' cognitive abilities and general intelligence (Frey and Detterman, 2004), and the College Board continues to encourage universities to consider SAT/ACT scores in conjunction with high school GPA when making admission decisions (Kobrin, Patterson, Shaw, Mattern, & Barbuti, 2008). However, research has also supported the notion that variance in educational outcomes—most often quantified as collegiate GPA—is explained by more than just intelligence. Non-cognitive factors such as personality and motivation play irrefutable roles as mediators and independent predictors (Busato, Prins, Elshout, & Hamaker, 2000; Hazrati-Viari, Rad, & Torabi, 2012). It would therefore appear that while important, ability is not the sole determinant in academic outcomes—motivation is also a crucial element. National Basketball Association player Kevin Durant excellently summarized this phenomenon in his assertion that "Hard work beats talent when talent fails to work hard."

"Hard work" in the academic context of coursework reflects increased expenditure of effort in the pursuit of class-related outcomes, such as passing grades. A student's ability to acquire knowledge may prove necessary but insufficient in obtaining these outcomes—while high cognitive ability may facilitate learning and mastery of course material, classes increasingly incorporate more than raw exam performance into final grade calculations. The additions of homework assignments, attendance credit, term papers, and group projects represent further hurdles that must be crossed on the path to success, and provide an opportunity for non-cognitive traits and dispositions to more strongly predict academic success. Far from being a formulaic

conversion of intellect to performance, classroom success has expanded into a complex equation of personality, self-efficacy, and endurance. Added together in the right proportions, these factors produce engaged students with high GPAs.

Despite a large body of student motivation research, this equation remains unsolved. As such, the potential benefits resulting from enhanced understanding of how motivation and ability interact in academic and occupational contexts stand unclaimed. For I-O researchers in particular, one need only look at the literature to note an overlap between meta-analytically-supported predictors of academic performance and job performance. Conscientiousness is the main such predictor (Barrick & Mount, 1991; O'Connor & Paunonen, 2007; Schmit & Ryan, 1993). This overlap aligns with the weighing of indicators of student quality—such as obtaining a dual-major degree *summa cum laude*—in selection decisions. Further examining models that link academic performance with students' personal characteristics not only provides researchers with an understanding of how successful and motivated students transition into similarly-performing employees, but also grants practitioners confidence in the utilization of academic outcomes in selection decisions, particularly when candidates may have comparatively little job experience.

Additionally, academic outcomes shape the workforce before newly-minted graduates apply for jobs by influencing which subjects students choose to pursue as careers. The phenomenon of success in a subject leading to strengthened interest in a subject is explained through both Expectancy-Value Theory (Wigfield & Eccles, 2000) and Holland's (1973) Theory of Vocational Choice. Job forecasts display a growing concern for maintaining student interest in the fields of Science, Technology, Engineering, and Mathematics (STEM). Understanding correlates of STEM success—and by extension, cultivating performance and encouraging future

interest in these fields of study—is particularly critical. As a special report from the President's Council of Advisors on Science and Technology explains, the United States is expected to sustain a deficit of one million STEM graduates throughout the next decade (Olson & Riordan, 2012). The proposed study therefore aims to examine non-cognitive predictors of academic success within the specific context of mathematics. Implications will be drawn for retention of students in STEM.

Theories of Motivation and Non-Cognitive Predictors

Research consistently demonstrates that personality serves as a predictor of academic success (Wolfe & Johnson, 1995), and its relatively enduring and stable nature from childhood through maturation attests to its practical utility as a predictor across time (Shiner, Masten, & Roberts, 2003). Despite the strength of these findings, researchers such as Tett and Christiansen argue that the predictive power of personality has been diluted by an overreliance on trait averages (2007). This argument draws credibility from the distinctions between general and specific individual differences. Though an overarching "personality" factor has been proposed (Van der Linden, te Nijenhuis, & Bakker, 2010), general individual differences more often refer to broader personality traits like agreeableness that are composed of multiple behavioral tendencies. These subfacets—often subscales on general personality measures—represent specific individual differences.

Specific personality traits warrant examination due to their accuracy in capturing behavioral differences in trait-relevant situations (Costa & McCrae, 1995). While general individual differences are useful for comparing patterns of personality across cultures, specific differences have been presented as superior for use in predicting particular patterns of behavior, such as those of interest in selection decisions (Funder, 2001). As the current study draws

implications for the selection and retention of STEM professionals as well as students in mathematics, the comparison of two specific individual traits is appropriate. However, the popularity of general individual difference measures means that a broader operationalization of personality should not be entirely excluded from examination.

Arguably the most popular general theory of personality, the Five Factor Model as presented by Digman (1990) posits *openness to experience*, *conscientiousness*, *extraversion*, *agreeableness*, and *neuroticism* as the key dimensions of personality. The five-factor structure has been found to be a good fit for student data (Schmit & Ryan, 1993), and while studies have found academic success to correlate with openness to experience (Komarraju & Karau, 2005) as well as agreeableness (Farsides & Woodfield, 2003), conscientiousness remains the strongest predictor for both domestic and international students (O'Connor & Paunonen, 2007; Geramian, Mashayckhi, & Ninggal, 2012).

Encapsulating an individual's attention to detail and self-control, conscientiousness reflects one's self-control, orderliness, perfectionism, and general industriousness (MacCann, Duckworth, & Roberts, 2009). It is often the most significant personality predictor accounting for variance in examination grades (Chamorro-Premuzic & Furnham, 2003), and its underlying facet of self-discipline has been found to predict academic performance better than IQ and fluid intelligence, across extended periods of time, and even when controlling for high school GPA and SAT scores (Chamorro-Premazic & Furnham, 2008; Duckworth & Seligman, 2005; Lounsbury, Sundstrom, Loveland, & Gibson, 2003; Noftle & Robins, 2007).

The process by which conscientiousness positively affects academic performance can be explained through two lines of reason. First, students with high attention to detail and orderliness are less likely to forget about important assignments due to their organization and high

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awareness of course requirements; the behavioral patterns associated with this personality trait lead to the formation of successful classwork-completing habits (O'Connor & Paunonen, 2007). Gray and Watson (2002) further demonstrated the connection between class-positive habits and conscientiousness when they found that conscientious students maintained earlier sleep schedules (such that they awoke earlier in the day) and performed better academically, though the degree and direction of causality were neither suggested nor tested.

The second factor that must be considered when analyzing the contribution of conscientiousness to student success is its interaction with student motivation. In addition to acting as an individual predictor of academic outcomes, conscientiousness interacts with self-motivation, such that individuals high on either trait earn higher GPAs than individuals low in both (Cheng & Ickles, 2009). The relationship between personality and academic performance is also partially mediated by academic-specific motivation (Hazrati-Viari et al., 2012), suggesting that the dispositions of successful students naturally lead to higher ambition in educational settings.

Self-Determination Theory (SDT; Ryan & Deci, 2000) identifies three primary types of motivation, with six associated styles of regulation. In the SDT framework, motivation exists on a continuum from internally- to externally-maintained, with intrinsic motivation expressed through interest and inherent enjoyment in completing a task. In contrast, individuals who are high in extrinsic motivation act in order to comply with standards, achieve rewards, or avoid punishment. Connections between conscientiousness and SDT motivation type indicate that highly-conscientious students tend to possess high intrinsic motivation to know (IM-K; indicating trait-level appreciation for knowledge) as well as high intrinsic motivation to accomplish (IM-A; relating to the achievement-striving facet of conscientiousness), and

commonly display self-regulation via identification with their role as a student and introjection—a type of regulation characterized by the imposition of internally-controlled rewards and punishment (Gray & Watson, 2002; Ryan & Deci, 2000). When considering findings that persistence in STEM subjects is linked to one's self-concept as a scientist or mathematician (Graham, Frederick, Byars-Winston, Hunter, & Handelsman, 2013; Degol, Wang, Zhang, & Allerton, 2017), the relevance of understanding the influence of personality grows apparent.
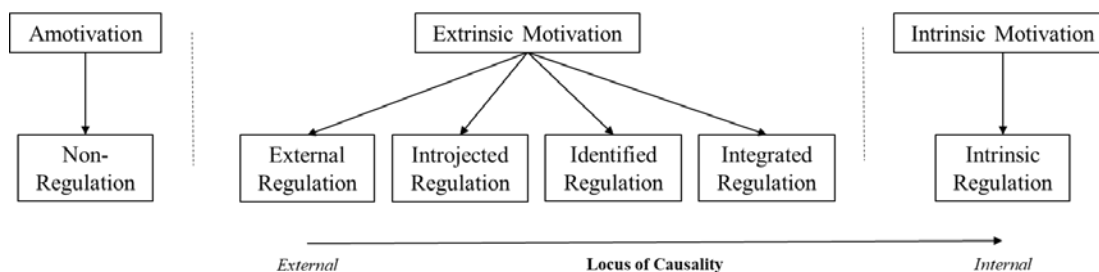

Figure 1: Self-Determination Theory framework as proposed by Ryan & Deci (2000). Less self-determined individuals are characterized by motivation patterns on the left, while highly self-determined individuals fall within the rightmost categories.

As conscientiousness is associated with more intrinsic forms of motivation, separate attention should be paid to introjected, identified, and integrated regulation, which remain vulnerable to external, non-self sources of influence—such as setbacks and difficulties—that may ultimately impact motivation levels. For example, a female student may initially pursue chemical engineering as a major due to the fact that she views herself as a scientist—perhaps due to early encouragement from parents or teachers. In alignment with identified regulation, the student's desire to become a chemical engineer is partly internalized, and she is motivated to succeed in chemistry courses in order to maintain congruence with her scientist self-concept. However, poor performance on a difficult exam may serve as an external deterrent: the low score directly conflicts with her internalized self-image as a scientist, reducing her motivation to pursue chemical engineering. When faced with a situation like this, conscientiousness as a broad

trait falls short in predicting whether a student will drop out. Attrition is not the only option; some students exert more effort when faced with academic setbacks or personal challenges while others languish in disappointment. Thus, the inclusion of measures of persistence is crucial for developing a well-rounded understanding of the non-cognitive factors contributing to student success.

Get Gritty or Get Quitty: The Persistence Framework

An individual's interest or desire to pursue topic mastery, completion of a degree, or career placement arguably possesses secondary importance to the matter of whether they actually exert enough effort to do so—an observation that has not gone neglected by researchers. Most prominently, the concept of grit (Duckworth, Peterson, Matthews, & Kelly, 2007) has emerged as a popular quantification of persistence in both academic and non-academic environments. In order to better appreciate the contribution of grit to the persistence literature, however, an examination of an overarching model of persistence is warranted.

Proposed in the context of collegiate STEM learning, the persistence framework attempts to encapsulate the process by which a student gains confidence and motivation to personally identify with the role of a scientist, which consequently leads to further confidence and fuels the student's desire to learn more science (Graham et al., 2013). The role of confidence in the model directly aligns with individual self-efficacy, or the belief that one is capable of learning the material and consequently performing well in the STEM field. While drawing heavily from the identified and introjected regulation aspects of self-determination theory, the persistence framework offers a unique insight into the cycle by which college students are driven to pursue STEM majors, and provides a streamlined explanation for the predictive validity of motivation-based constructs such as grit.

Grit is merely the latest incarnation of a concept dating back to 1915, when Edward Webb examined the role of "persistence of motives" in relation to character and personality. Defined as "perseverance and passion toward long-term goals," grit is a form of distilled perseverance, and has been found to predict GPA amongst Ivy League undergraduates as well as ranking in the National Spelling Bee (Duckworth et al., 2007). As a motivation-based trait rooted in endurance, grit is relevant for students in multiple disciplines, from pharmaceutical trainees to West Point military officer candidates—amongst which grit predicted persistence across four years of schooling when college entrance exam rank did not (Hammond, 2017; Kelly, Matthews, & Bartone, 2014). Grit consists of two dimensions: Perseverance of Effort and Consistency of Interests. The former dimension, Perseverance of Effort, is more strongly correlated with conscientiousness, and as such is the stronger predictor of grades (Muenks, Wigfield, Yang, & O'Neal, 2017). Consistency of Interests, while sometimes found to have no significant predictive validity over the same, is more strongly associated with conscientiousness via an interaction with self-concept clarity, or the degree to which an individual possesses a clear and defined self-image (Fite, Lindeman, Rogers, Voyles, & Durik, 2017). As grit is presented as a specific individual difference, criticisms concerning its high correlation with conscientiousness raise questions as to the discriminant validity between the two constructs.

Grinding Down Grit

It is important to note that the validity of grit as a distinct, valid construct has been recently called into question (Credé, Tynan, & Harms, 2016). Item response theory has found the two subscales of grit to essentially amount to two independent constructs lumped together, and the Short Grit Scale has been criticized as failing to accurately capture "long-term" goals—a critical component of grit's quantification of sustained effort (Muenks et al., 2017; Tyumeneva,

Kardanova, & Kuzmina, 2017). Additionally, the significant commonalities shared by grit and conscientiousness bode ill for the presentation of the former as providing distinct predictive validity over and beyond the latter.

The issues with grit exceed those of measurement: it is an idea that has trundled through multiple incarnations, rising and falling in accordance with research trends. Adopting names such as "Hardiness," "Perseverance," and "Endurance," recent interest in the trait of grit has been questioned as a symptom of a multidisciplinary jangle fallacy—the faulty consideration of a rebranded construct as a unique contribution to the literature (Block, 1995; Muenks et al., 2017; Whiteside & Lynam, 2001).

When assessing the research contradicting the trait, the argument for abandoning the construct in favor of a psychometrically stronger measure grows stronger. The utility of grit as a construct lies primarily in its facet of perseverance, yet it possesses only a moderate relationship with performance, much of which is due to shared variance with trait conscientiousness (Credé et al., 2016). The persistence framework offers one explanation for a mechanism by which grit predicts academic performance—especially in mathematic contexts, where math achievement leads to the formation of a self-concept as a mathematician or math-able student (Rinn, McQueen, Clark, & Rumsey, 2008). However, no studies have formally examined whether grit is the sole—or even primary—construct of perseverance supporting the persistence framework. The current study hypothesized that it would prove inferior to more robust measures when considering a broader interpretation of student expectation. While the persistence framework and Self-Determination Theory emphasize the formation of relevant self-concepts as means of inspiring continued motivation, consideration of Expectancy-Value Theory leads to the

conclusion that mere grit is insufficient for predicting continued motivation, particularly in the context of taxing academic subjects such as math.

A theory of belief-based motivation, Expectancy-Value Theory presents motivation as a comparison of expectations (Wigfield & Eccles, 2000). It posits that the amount of effort an individual is willing to devote to a given task is a direct function of both a) the extent to which they expect to successfully complete the task and gain rewards, and b) the expected value of the potential outcome. In the context of the classroom, this implies that student effort is inextricably tied to expected performance in the course. This theory may be applied generally: a student is motivated to exert effort in learning new material (cost) when they expect to earn a good grade (reward).

More specifically, say a student is provided with an opportunity to earn extra credit on an exam, the costs of which include extra time and exertion of mental effort. From an individual differences standpoint, one would expect conscientious or gritty students to complete the assignment due to their industrious and persevering nature. In contrast, the Expectancy-Value perspective asserts that it is not necessarily the conscientious student who will be motivated to complete the extra credit, but the student who expects the effort to be worthwhile. Whereas grit attributes persistence to trait-level perseverance, Expectancy-Value Theory therefore acknowledges the role of an individual's value judgments and self-efficacy.

Academic Resilience: The Missing Piece

Expectancy-Value Theory is not incompatible with the persistence framework or Self-Determination Theory—rather, it facilitates joint consideration of the two. As in the persistence framework, student self-concepts and their resulting efficacy beliefs are still accounted for in how they influence student expectations of success. Expectancy-Value Theory does not attribute

a locus of causality to the resulting motivation, meaning that the equation of costs and benefits may be judged in the context of either extrinsic or intrinsic sources of motivation. Therefore, the persistence framework's alignment with SDT's "Identified" regulatory type is considered, but the importance of external influences on perceptions of success is not ignored. The superiority of applying Expectancy-Value Theory to the persistence framework, the current study argues, lies in its ability to account for individual differences in response to failure, thus providing an avenue to examine resilience.

The persistence framework, concerned as it is with the cycle of learning-confidence-motivation-self-concept, ultimately fails to account for failure. When the self-concept is challenged, the framework is stalled or broken. The cycle is disrupted, and persistence discontinues. Student attrition is the implied outcome. However, one need only look at the literature of clinical psychologists to understand that individual responses to adversity differ: while some students' grittiness enables them to persist in pursuit of their goals, other students' resilience allows them to recover after challenging events.

While individual trait resilience reflects one's adaptation and perseverance against lifetime trauma, researchers have argued for the necessity of a measure of one's ability to overcome adversity in the academic setting (Cassidy, 2016; Connor & Davidson, 2003). Accordingly, academic resilience has been presented as a contextually-specific, more valid measure of student ability to surpass academic misfortunes (Colp & Nordstokke, 2014; Martin & Mash, 2006). Academic resilience specifically possesses promising implications for the persistence framework: if it is the glue by which persistence is maintained—or rather, the springiness of the pathways composing the framework—then a break in the motivation-confidence cycle of perseverance need not result in complete attrition from the subject.

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When one accounts for the grueling nature of difficult subjects such as mathematics, academic resilience may prove all the more important. Math has been labeled by some researchers as "cognitive abuse" due to its rigidity and reliance on specific methods of problem solving (Johnston-Wilder & Lee, 2010). Indeed, as highlighted by Johnston-Wilder and Lee, the very nature of learning math requires students to adjust their attempts when met with failure; abandoning unsuccessful approaches and adopting novel ones to complex problems leads to less frustration than may sheer perseverance (2010). Grit is therefore a less desired trait than resilience in this context; the ability to adapt one's tactics and avoid discouragement from an incorrect answer becomes the ideal.

Taking into account the superior fit of academic resilience in the persistence framework by virtue of Expectancy-Value Theory, as well as the construct and measurement issues associated with the prevailing trait of grit, it becomes apparent that further research is warranted. Therefore, the current study proposed that additional variance in academic outcomes may be explained through the examination of academic resilience, rather than the longstanding popular conception of grit.

Hypothesis 1: Academic resilience will provide incremental validity over an individual's grit and conscientiousness when predicting course performance.

It was also thought that academic resilience should serve as a mechanism by which students recover from initial failure, such that individuals with different levels of academic resilience would exhibit a different relationship between early failure and subsequent performance. Therefore, it was hypothesized that academic resilience would serve as a moderating[1] variable:

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[1] Academic resilience was initially thought to be the mechanism by which students were able to recover from poor performance, and thus mediated the relationship between early poor performance and subsequent recovery. The specification of

Hypothesis 2A: Academic resilience will moderate the relationship between early poor test performance and subsequent course recovery, such that for students with high academic resilience, low scores on initial unit exams will be associated with greater scores on the cumulative final, while students with low academic resilience will be associated with low or insignificantly different grades.

Hypothesis 2B: No moderating effect of grit or conscientiousness between poor initial performance and subsequent recover will be observed.
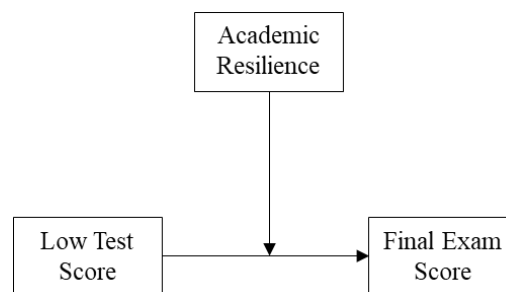

Figure 2: A visual representation of Hypothesis 2A, re-specified.

Gender and STEM

Also worth noting are the potential implications the study of grit, conscientiousness, and academic resilience provide to the large volume of research surrounding the STEM gender gap. Studies indicate that women remain underrepresented in STEM fields—though some fields (such as biology and chemistry) possess a more balanced male-female ratio than others (Beede, Julian, Langdon, McKittrick, Khan, & Doms, 2011; Cheryan, Ziegler, Montoya, & Jiang, 2017). Gender differences in math, specifically, indicate that males tend to score better on standardized tests, while girls earn higher grades in math classes (Kimball, 1989).

Hypothesis 2a/b in this manner misrepresented the expectations of the author, and thus Hypothesis 2 was re-specified to describe the intended moderation effect.

While theories abound as to the underlying causes of gender differences in STEM, much of the research concludes that the symptoms derive from a lessened tendency for females to persist in the pursuit of STEM majors (Chen, 2009; Griffith, 2010; Shaw & Barbuti, 2010). Persistence in these fields is linked to a sense of belongingness, with the relationship stronger for women than men (Lewis et al., 2017; Smith, Lewis, Hawthorne, & Hodges, 2013). Lowered sense of belongingness in STEM may therefore lead to relatively stronger lowered motivation to persist for females—or, in study-relevant terms, may lead to lowered passion and perseverance in pursuit of goals. Gender differences have also been found in math anxiety, such that females experience higher levels (Betz, 1978). As math anxiety has been correlated with both academic procrastination and lowered math achievement, this may serve as a potential explanatory factor for the continued STEM gender gap (Walsh & Ugumba-Agwunobi, 2002).

While the above research indicates a broad spectrum of gender-associated factors are likely at play in the context of female persistence in STEM fields, it should be noted that multiple factors must be present for female attrition to differ from that of males. More specifically, gender differences in attrition are most significant when three criteria are met: the class composition is primarily male, external stereotyping signals are present, and poor academic performance is obtained (Kugler, Tinsley, & Ukhaneva, 2017). While Kugler and colleagues identified these three signals as important factors in female discontinuation from STEM fields, they did not postulate as to the underlying mechanisms or vulnerabilities exploited by these factors. As academic resilience both accounts for recovery from adverse events—such as earning low grades—and encapsulates the self-efficacy aspects of the persistence framework, it was proposed that:

Hypothesis 3: Gender will moderate the relationship between academic resilience and performance, such that the relationship will be stronger for females.
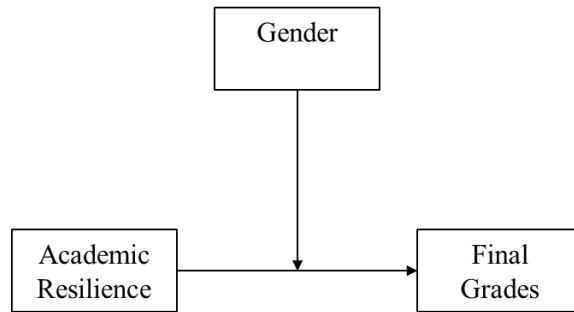
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                    ┌──────────────┐
                    │    Gender    │
                    └──────┬───────┘
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┌──────────────┐    ┌──────────────┐
│   Academic   │───▶│    Final     │
│  Resilience  │    │    Grades    │
└──────────────┘    └──────────────┘
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Figure 3: A representation of Hypothesis 3.

The Current Study

Using expectancy-value theory as a framework, the current study proposed the examination of academic resilience as an important and unique predictor of student grades, due to its ability to explain individual differences in responses to academic setbacks such as a poor initial exam score. As the difficulty of mathematics has led the subject to be viewed by students with fear, anxiety, and dread (Betz, 1978; Rodarte-Luna & Sherry, 2008), the role of academic resilience was analyzed specifically in the context of collegiate math courses.

Methods

Participants

A total of 279 undergraduate students at a large southeastern university were recruited from four sections of a lower-level analytics course required for business majors. The business course provides an introduction to basic statistics, and participation in the study was compensated with the application of extra credit towards the student's overall grade in the course. The sample had an average age of 19.97 and was slightly more male in composition (167 male, 112 female), which is consistent with previous statistics on the proportion of male to female business students (Daymont & Andrisani, 1984).

It was not expected that high intrinsic motivation for mathematics would serve as a confounding variable. The sample consisted of students who were not declared STEM majors, but rather taking a mathematics-based course to supplement their business major. Therefore, it was assumed that students in the sample were not generally motivated to engage in math for pure, intrinsic enjoyment of the subject. In the absence of this math-based intrinsic motivation, perseverance and thoughtfulness were thought to be all the more important for course performance.

Measures

Academic Resilience. The Academic Resilience Scale (ARS-30; Cassidy, 2016) was the selected scale for measuring a student's academic resilience. The measure consisted of a vignette describing an academically adverse event, followed by thirty items describing various cognitive-affective, emotional, and behavioral responses. Students were asked to rank the degree to which each response "sounds like them" on a 5-point Likert scale.

Grit. The eight-item Short Grit Scale (Grit-S) from Duckworth and Quinn (2009) was used to measure the trait of grit: perseverance and passion in the pursuit of long term goals. Though a slightly longer version (twelve items) of the scale was available, the shorter scale was considered to be psychometrically stronger (Duckworth & Quinn, 2009) and consists of two subscales: Perseverance of Effort and Consistency of Interests. Sample items included "Setbacks don't discourage me," as well as "I finish whatever I begin." This scale was the most widely used measure of grit, and has been employed in both exploratory and intervention studies. As such, its popularity identified it as the ideal point of comparison for the newer construct of academic resilience.

Conscientiousness. The School-Specific Conscientiousness Scale (Schmit, Ryan, Stierwalt, & Powell, 1995) measured the personality trait conscientiousness. The scale consisted of 24 items measuring three dimensions: self-discipline, achievement-striving, and competitiveness. Responses were measured on a 7-point Likert scale. Each dimension contained eight associated items, worded in such a manner as to reflect the academic context of university life (i.e.: "I have a lot of self-discipline in my course work"). Research indicated that validity of self-report personality scores increased with the addition of a frame of reference (Schmit et al., 1995). In this case, the incorporation of student-relevant university context into measure items constituted an additional reference point for respondents, and was expected to provide an accurate measure of student conscientiousness.

Mathematic ability. In order to control for initial mathematic ability, self-report SAT/ACT scores were collected, as well as the student's current collegiate GPA. Research has indicated that despite some tendencies for positive bias and overestimation of self-reported scores, the validity of these self-reported academic achievement scores remains high, with correlations between self-report and official GPA as high as .97 (Cassady, 2001; Cole & Gonyea, 2010). Inaccurately-reported GPA and standardized test scores bear the potential for range restriction of these variables—with slight inflation bearing the potential to skew the distribution, but descriptive statistics eliminated concerns regarding this issue. Additionally, the high correlations between self-report and official GPA point to artificial inflation as an issue of minimal magnitude, with overestimates averaging around 0.13 points on a 4.00 scale (Cassady, 2001).

Mathematic performance. In order to compare the incremental validities of grit, academic resilience, and conscientiousness as predictors of course performance (H1), grades for

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each unit exam in the business analytics course were collected. As all sections of the business analytics course were graded under the same weighting, raw scores were used in lieu of percentages. Final course performance was also examined via students' final grades in the course. Scores on the cumulative final exam were expected to reflect final grade in the course, but were also included in analyses.

Academic recovery. To test the "Recovery Hypothesis" (H2) concerning the moderating role of academic resilience, early failure was operationalized as the magnitude of each student's worst performance, or failure (MoF). This magnitude represented the variability between a student's typical performance and their worst performance, and was calculated by subtracting their lowest unit exam score from their average unit exam score. Scores on the cumulative final exam were then regressed onto this value to determine the pattern of relationship between extreme failure (i.e., having a large MoF) and subsequent performance.

Demographics. In order to test for the potential moderating effect of gender on academic resilience (H3), as well as for routine examination purposes, basic demographic information was collected on participants. Gender, ethnicity, age, and primary language spoken were collected.

Results

Correlations for study variables are displayed in Table 1. Consistent with previous research, grit strongly correlated with conscientiousness ($r = .62$, $p < .01$). Academic resilience also correlated with conscientiousness ($r = .47$, $p < .01$), but moderately. Academic resilience correlated with overall GPA ($r = .30$, $p < .01$) as did grit ($r = .25$, $p < .01$), though both effects were small. Notably, the number of missed responses to survey items was negatively correlated both with an individual's GPA ($r = -.14$, $p < .05$) and their conscientiousness ($r = -.17$, $p < .05$).

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Table 1

Correlations Among and Descriptive Statistics For Key Study Variables

	M (SD)	1	2	3	4	5	6
1. Sex	39% Female	--					
2. GPA	3.13 (.55)	.09	--				
3. Grit	3.30 (.57)	-.07	.25**	**.70**			
4. Consc.	115.16 (20.86)	.12*	.53**	.62**	**.91**		
5. Academic Res.	115.83 (13.73)	.05	.30**	.30**	.43**	**.87**	
6. Missed	.43 (1.62)	-.00	-.14*	-.07	-.17**	-.07	--

Notes. N's range from 279 to 261 due to missing data. For sex, 0 = male, 1 = female. Consc = conscientiousness. Academic Res. = academic resilience. Missed = # of missing responses.
* $p < .05$; ** $p < .01$.

Hypothesis 1

Hierarchical regression demonstrated partial support for Hypothesis 1, a summary of which may be found in Table 2. Academic resilience predicted final course grade above and beyond that of grit ($\Delta R^2 = .014$, $p = .05$), but the additional validity lost significance when conscientiousness and GPA were entered into the model first ($\Delta R^2 = .004$, $p = .18$). Similarly, grit predicted course final grade above and beyond that of academic resilience ($\Delta R^2 = .04$, $p < .01$), but not over GPA and conscientiousness ($\Delta R^2 = .00$, $p = .66$). When predicting a more specific outcome (total exam grades), only academic resilience provided additional predictive validity above that of grit ($\Delta R^2 = .05$, $p < .01$). Neither grit nor academic resilience significantly predicted exam grades over GPA and conscientiousness.

Table 2: Hierarchical regression results for Hypothesis 1

Step 1	R^2 Final Grade	R^2 Exam Grades	Step 2	ΔR^2 Final Grade	ΔR^2 Exam Grades
Grit	.060	.030	Academic Resilience	**.014, _p_ = .05***	**.050, _p_ < .001***
Academic Resilience	.035	.070	Grit	**.043, _p_ = .001***	.011, _p_ = .08
GPA, Conscientiousness	.474	.381	Academic Resilience	.004, _p_ = .18	.007, _p_ = .09
GPA, Conscientiousness	.474	.381	Grit	.000, _p_ = .66	.000, _p_ = .87

Hypothesis 2A/B

To test whether academic resilience exerted a moderating effect between poor exam performance and subsequent performance on the final, Model 1 of the PROCESS Macro (Hayes, 2013) was used to regress final exam performance onto a student's worst performance magnitude, including GPA and unit exam scores as covariates. As the MoF reflects a measure of performance variability, unit exam scores were included in the model as covariates in order to account for a student's operating level of performance.

No main effect of academic resilience on final exam performance was observed. Magnitude of failure demonstrated a significant main effect on final exam score, such that a greater magnitude of failure (i.e., "bombing a test") was associated with a lower grade on the cumulative final. However, the interaction of academic resilience with MoF was significant, such that the relationship between a student's worst performance and their grade on the final lost significance as academic resilience increased. This relationship is illustrated in Figure 1. That is, for students with lower-than average levels of academic resilience (designated as ARS -1 SD in Figure 1), obtaining a lower-than-usual exam score was significantly related with poorer performance on the cumulative final. The strength of this relationship was moderate (R^2=.25),

implying that for these academically non-resilient individuals, suffering a large failure significantly reduces their future performance. Meanwhile, the cumulative final exam score for students with average (ARS 0 SD) or high levels (ARS +1 SD) of academic resilience was unaffected by a low exam score. For these individuals, the insignificant R^2 point to the minimal impact of early failure and subsequent performance—their grade on the final exam is not compromised by poor unit test results. Thus, Hypothesis 2A was supported.
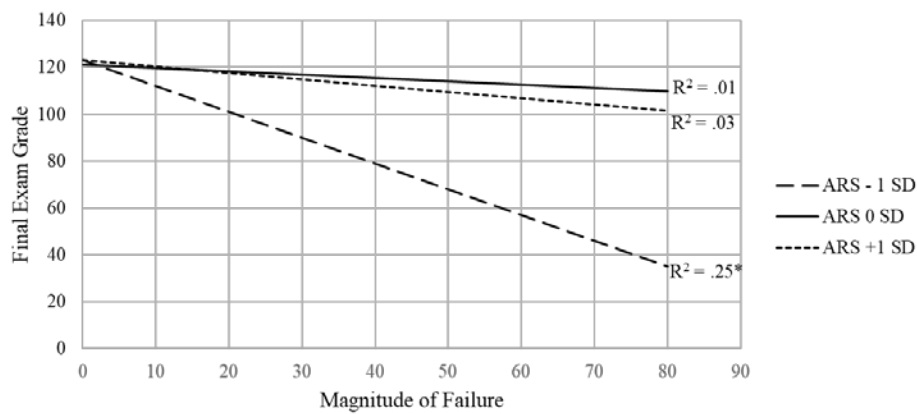

Figure 4: Effect of failure on performance at levels of academic resilience

Hypothesis 2B was partially supported. Inconsistent with expectations, the interaction between grit and magnitude of failure was significant, with a similar interpretation as that of academic resilience and MoF. This interaction is illustrated in Figure 2. Again, individuals with lower-than-average levels of grit (designated as Grit -1 SD) saw a significant relationship between the severity of failure and final exam performance (R^2=.15). The relationship between suffering a poor performance and obtaining a poorer grade on the cumulative final weakened as levels of grit increased, losing significance altogether at average (Grit 0 SD) and high (Grit +1 SD) levels of grit. As with academic resilience, these results point to early failure possessing greater impacts for students with lower levels of the trait in question.
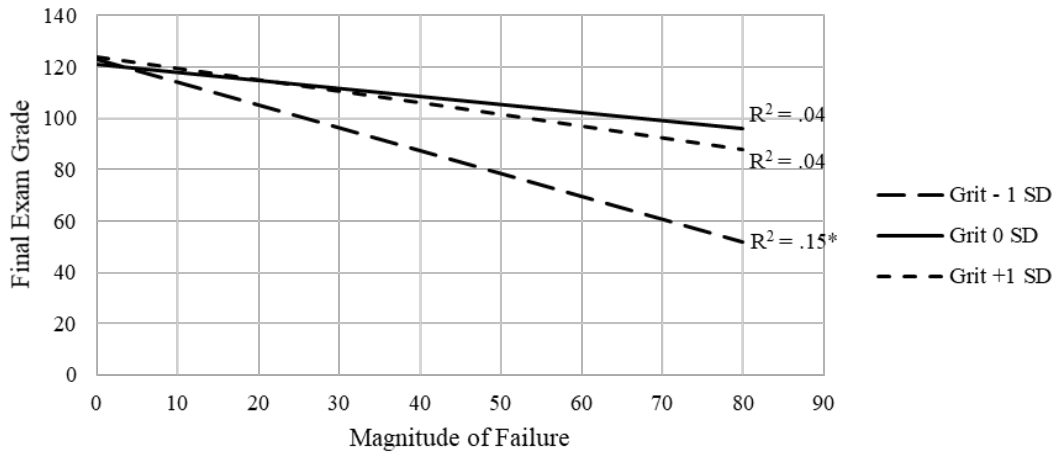
21

Figure 5: Effect of failure on performance at levels of grit

As hypothesized, the interaction between conscientiousness and magnitude of failure was not significant, with no effect of student conscientiousness on the relationship between poor performance and scores on the final exam. As seen in Figure 3, the relationship between early failure and subsequent performance remained insignificant regardless of whether students were less conscientious than average (Cons -1 SD), of about average conscientiousness (Cons 0 SD), or more conscientious than average (Cons +1 SD). Therefore, levels of conscientiousness did not moderate the relationship between MoF and final exam grade.

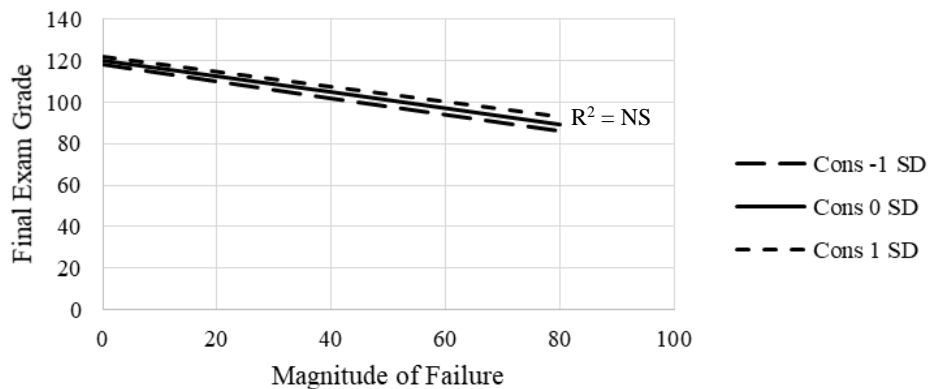Figure 3: Effect of failure on performance at levels of conscientiousness

Figure 6: Effect of failure on performance at levels of conscientiousness

Hypothesis 3

Model 1 of the PROCESS packaged was used to test Hypothesis 3. No support was found for Hypothesis 3 regarding the moderating effect of gender on academic resilience or grit. The interaction remained insignificant regardless of whether the outcome variable was specified as total exam grades or final course grade.

Discussion

The current study investigated the comparative predictive utility of two motivation-based constructs in the context of a collegiate mathematics course. Drawing upon the belief-based method of persistence aligned with Expectancy-Value Theory, academic resilience was expected to outperform grit in its ability to better explain variance in overall exam grades, final course performance, and recovery from failure. Both variables were compared to the well-established, more general individual difference of conscientiousness.

Grit and academic resilience performed comparably in predicting course outcomes with a few exceptions, demonstrating some predictive utility as specific individual differences. This utility ultimately failed to surpass that provided by GPA and conscientiousness. However, it may be the case that the outcomes examined were overly general in nature, thus reducing the predictive impact of specific individual differences. As general individual differences are more useful in predicting broad outcomes, the restriction of Hypothesis 1 to composite course outcomes may contribute to the underperformance of grit and academic resilience in comparison to conscientiousness.

The reverse may also be true: another potential explanation for the insignificance of Hypothesis 1 is that conscientiousness functioned as a specific individual difference due to the

inclusion of the academic context in the school-specific conscientiousness scale. Under this assumption, the selected performance metrics were indeed specific outcome variables, but the inclusion of school-specific conscientiousness as a specific predictor rendered academic resilience and grit obsolete. However, this logic does not offer a satisfactory explanation for the significance of GPA in predicting the selected outcomes.

The failure of grit to outperform academic resilience in predicting overall exam performance—a more specific outcome than final course grade—grants credence to the prior explanation that the selected outcomes were too general. Therefore, it may be necessary to adopt a narrower operationalization of classroom success. Given that the changing nature of the classroom has increased the importance of assignment and participation grades, examining these component parts of performance is appropriate. In anticipation of this, specific outcomes like homework completion were collected as part of the current study, and will be analyzed at a further date.

The Insulating Effect

It was hypothesized that academic resilience would provide an advantage in the face of academic adversity, operationalized as comparatively poor exam performance. That is, academically resilient students would view academic failure as a challenge or opportunity for improvement, thus inspiring an increase in effort that would result in higher scores on the final exam than those attained by non-resilient students. Though academic resilience in this context was hypothesized to convey an advantage to individuals high in the trait, results indicated that it acted as a protective factor against continued failure. The absence of this trait thus posed a detriment to student success: students low in academic resilience demonstrated a continued pattern of negative performance following a large magnitude of failure. For students high in the

trait, the lack of relationship between failure and subsequent performance indicates an insulating effect against discouragement. Promisingly, this effect was not observed with conscientiousness, indicating that it is indeed derived from a more specific trait.

Unexpectedly, grit displayed a similar insulating effect, such that its interaction with magnitude of failure was significant. Though not hypothesized, several explanations are proposed. Firstly, it may be the case that academic resilience and grit are not differentiated enough—either theoretically or empirically—to provide differential predictive utility in the selected outcome variables. In an attempt to address concerns over the grit/conscientiousness jangle fallacy, the current study may simply be operating under the same mistaken assumption that minor differences in definition will be reflected in observed phenomena. However, the fact that academic resilience correlated less strongly with conscientiousness than grit did suggests the occurrence of something beyond construct overlap.

Indeed, it may be the case that academic resilience and grit achieve similar outcomes via different means. As per the principle of equifinality, the traits might have acted in different ways to the same end; the mechanisms of each individual difference were neither hypothesized nor tested in the current study. The perseverance associated with grit lends itself to the hard work necessary for recovering from an academic setback—perhaps leading to increases in the total amount of time spent practicing homework problems.

Though academic resilience (as measured by the ARS-30) consists of a perseverance subfacet, its emotional response and help-seeking dimensions emphasize flexibility and adaptation. Therefore, one might expect an academically resilient response to failure to entail a shift in preparation strategy. That is, a student would interpret the setback as a signal that their current preparation strategy (such as completing online quizzes) is insufficient to achieve their

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desired results and would add or switch to a new strategy (such as participating in extra credit opportunities or completing homework assignments).

In the context of Expectancy-Value Theory, it could be the case that grit enables students to ignore outside signals of misfit, such that failure does not alter their expected outcomes. Therefore, grit may strengthen the persistence framework by shielding an individual's self-identification with a given occupation. Academically resilient students, on the other hand, may register failure to a degree where it threatens their expected outcomes, prompting a boost in motivation and modification of academic study behaviors. If this is the case, failure would be more likely to challenge a resilient student's identification with their desired occupation, but ultimately would spark an adaptive response resulting in maintenance of the persistence framework. If this is the case, one would expect identified regulation to be more associated with grit than with academic resilience. Future research examining failure-induced changes in self-efficacy may shed light on these underlying mechanisms.

Gender

No significant moderation effect of gender was observed in the current study. Males and females possessed similar levels of grit and academic resilience (though females were more conscientiousness), and the variables of interest predicted academic outcomes similarly for males and females. In accordance with the Triple Threat Hypothesis, the analytics course was predominantly male—albeit by a slim 10% margin. However, the second signal of external stereotyping signals was not fulfilled, as the professor of the course was female. Combined with the fact that performance in an analytics course be of lessened importance to a female student's identification as a business major, it may be that the classroom sampled bore only a minor resemblance to the academic context stimulating female attrition.

Time to Quit?

The question posed at the beginning of the study remains: is grit still a viable specific individual difference, given its theoretical and empirical inconsistencies? This study suggests a tentative *yes*. When compared to academic resilience, grit performed similarly in all analyses conducted. In the most notable exception, academic resilience predicted total exam scores above and beyond grit, while the reverse failed to reach significance. This indicates the two constructs likely interact with classroom performance in slightly different manners.

From a psychometric perspective, academic resilience as measured by the ARS-30 (Cassidy, 2016) initially appeared slightly sounder. The reliability for the scale measured well within the acceptable range, while grit's reliability remained borderline acceptable. This may seem to indicate the ARS-30 is a more psychometrically sound measure, but in actuality the number of items in the ARS-30 may simply be inflating its alpha-value. Therefore, the apparent difference in reliability does not warrant direct comparison.

As in previous studies (Credé et al., 2017), grit as measured by the Short Grit Scale (Duckworth & Quinn, 2009) correlated strongly with conscientiousness. The magnitude of this correlation was moderate, however, and the variance inflation factor was 1.62, well below the threshold of 10 associated with extreme collinearity (Kline, 2015). Additionally, the attenuating effect observed at high levels of grit but not conscientiousness indicates the former trait is operating independently enough to warrant consideration as a standalone variable. The correlation between academic resilience and conscientiousness—though less severe—was also significant, pointing to shared commonalities in the operation of these measures.

The overlap in performance of grit and academic resilience may indicate that the traits operate in tandem. Grit in this instance may be necessary but insufficient: it provides students

with the dedication and perseverance to endure the workload of an entire semester—thus explaining its correlation with conscientiousness—but it may be academic resilience that steps in to provide bursts of short-term motivation in response to negative outcomes. This explanation does not fully align with the obtained results—as both traits attenuated the impact of failure—but it begs the question as to whether grit and academic resilience would display the same effect for "mini failures" in homework assignments or quizzes.

Ultimately, both grit and academic resilience operated in a manner consistent with Expectancy Value Theory. Students with low amounts of either variable saw a significant relationship between a large magnitude of failure and a lower grade on the cumulative final, suggesting that their lack of grit or resilience left them vulnerable to discouragement and continued poor performance. Meanwhile, the lack of relationship between magnitude of failure and subsequent performance for students with higher grit or resilience supports the notion that these traits enable a student to resist reductions in expectations of future success, thus insulating them from lasting self-efficacy consequences of their own failure.

Future Directions

The nuances of academic reliance and grit are highlighted in this study, but not fully explained. As an insulating effect was demonstrated for both traits, future research should more thoroughly examine the processes and correlates of this interaction to better quantify and measure negative spirals in the classroom. So, too, should similar outcomes be examined in the context of the workplace. It may be the case that occupation-specific resilience performs similarly to academic resilience in relation to grit, but research must be done prior to drawing any conclusions about the sufficiency of simply measuring these outcomes with grit alone.

As mentioned previously, more specific classroom outcomes should be examined to better isolate the predictive relevance of these two traits. Findings here suggest that academic resilience may prove the superior predictor of specific academic outcomes; looking at assignment completion, attendance, and participation in a course will bring further understanding. Additionally, taking a measure of student expectancies or beliefs regarding their abilities and course outcomes may provide additional insight into the function of Expectancy-Value Theory.

Finally, the current study examined resilience and grit within a statistics course provided to business students. The results obtained here should be replicated in other courses—both mathematics and otherwise. It may be the case that pursuing a STEM major within a college of science provides an overarching context that alters a student's effort within a single course. Therefore, future studies should examine whether direct congruence between one's major field of study and a course's subject impacts the phenomenon observed in the current study. Doing so is merely the next step in parsing out the complexities of context-motivation interactions.

Conclusion

As reviewed by Baldwin (2009), the current climate at many universities is unfavorable towards undergraduates attempting to learn STEM, but research-backed interventions and campaigns are slowly promoting retention of STEM-aspiring students (Tsui, 2007; Graham et al., 2013). The interaction effects demonstrated in the current study emphasize the importance of non-cognitive traits in sustaining performance, illustrated through several course outcomes. The association of lower-than-average levels of grit and resilience with a failure to recover from initial poor performance points to these traits as contributing to classroom success insofar as they protect against derailment.

The current study therefore suggests that the main benefit of measuring specific traits like academic resilience and grit is not to supplement current predictors of performance, but rather to indicate a student's likelihood of overcoming or succumbing to any difficulties encountered. By identifying and focusing on students low in these traits of interest, persistence-based interventions may more directly target the individuals at risk of attrition. It is not time to quit with grit—rather, it is time to examine it in the context it is most suited for.

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