

Grit, motivation and university grades*

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Abstract

Many South African university students either do not complete their degrees or take a prolonged time to meet the minimum degree requirements, with significant cost implications. Identifying malleable drivers of academic success is an important starting point in designing policies and programs to improve student outcomes. To this end, we assess grit and intrinsic motivation as possible predictors of academic success, where motivation type is coded using text analysis of open-ended responses. We also investigate interactions between these traits. In line with existing literature, mostly in the USA and Canada, our results show that higher levels of grit are related to higher grades among Economic and Management Science students in a South African University. We further note intrinsic motivation as a significant predictor of grit levels. Our findings suggest that grade outcomes might be improved by interventions focusing on building grittiness in students.

Key words: Grit, motivation, higher education

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1 Introduction

Education is an important key to developing a country and improving equality among citizens. The importance of human capital development has become increasingly salient as most occupations require some form of tertiary education as an entrance criterion (Burks et al., 2015). However, numerous students either do not complete their degree, require extra time to graduate, or obtain their degree with only the minimum requirements, raising questions about the level of mastery acquired (Beattie, Laliberté and Oreopoulos, 2018). Given the importance of academic success in predicting job market outcomes, researchers have studied the impact of factors affecting academic success. The majority of these studies are from developed countries, particularly the United States and Canada; and there is far less literature investigating these factors in the developing world. In the South African context, we face similar challenges to those detailed by Beattie et al. (2018): An analysis of a 2011 cohort of students in South Africa found that only 29% of students completed their 3-year degree in 3 years, with only 58% completing by year 6 (Statistics South Africa, 2017).

Although many of the skills relating to academic success are established earlier in life with different access to resources and opportunities, there is a need for identification of malleable traits that also predict academic success. This will help to make policy recommendations on ways to encourage students to cultivate these traits. In the past decade, an increasing amount of literature describes the factors, besides high school grades, which affect a student's ability to graduate from a tertiary institution. These factors include a student's socioeconomic status, the secondary school attended¹, personality characteristics and the student's motivation type (Afzal et al., 2010; Beattie et al., 2018; Berkowitz and Hoekstra, 2011; Burks et al., 2015; Cyrenne and Chan, 2012; de Oliveira et al., 2013).

We are interested particularly in traits that are linked to academic success in South Africa. Based on existing developed country literature, we select two traits to investigate

¹In South Africa, three types of schools are evident: public fee-free schools (fully subsidised by the government), public fee-paying schools (schools receive funding from government and charge school fees to reduce class sizes and improve facilities) and independent private schools (fully funded through school fees).

in the South African context: Grit, defined as “the perseverance and passion for long-term goals” (Duckworth et al., 2007: 1); and motivation type, where people are categorised as either predominantly extrinsically or intrinsically motivated. These were selected because both have been found to predict academic success (see e.g. Alan, Boneva and Ertac, 2019 for grit and Afzal et al., 2010 for motivation type) and both can be learned (see Alan et al., 2019 for grit and Schwartz and Waterman, 2006 for motivation type). Because they can be learned and changed over time, these characteristics provide opportunities for interventions to assist students with academic success.

We use a survey of 420 first year economics students at a large South African university to investigate the impacts of grit and motivation type on grades achieved. In addition to exploring direct relationships with grades, we explore the relationship between motivation type and grit. Grit is measured using the widely-adopted survey introduced by Duckworth and Quinn (2009). We identify motivation type using text analysis. This is a novel approach that has only been used in one other study (Beattie et al., 2018): it allows us to analyse students’ spontaneous responses to questions about their motivation without prompting students with possibly socially desirable response options.

Only one other paper has considered the relationship between grit and university grades in South Africa. We build on this work by using a larger sample size and adding a variety of control variables which affect academic success, as well as including an investigation on the impact of motivation type on grades. We find that grittiness has a significant positive relationship with grades. Motivation type (intrinsic or extrinsic) is not a significant direct predictor of academic performance in our data. However, we note that intrinsic motivation has a positive and significant relationship with grit.

This paper proceeds as follows: Section 2 briefly reviews existing literature; Section 3 details the methodology used; results are reported in Section 4; and Section 5 concludes.

2 Literature review

2.1 Impact of grit and motivation type on university success

Duckworth et al. (2007) showed that individuals' non-cognitive traits affect their success in goal attainment. These authors consider grit, a combination of perseverance and passion, as a predictor of differences in achievement levels and success rates. Duckworth et al. (2007) developed a Likert-scale questionnaire to measure students' grittiness. The Grit-S questionnaire consists of two facets, consistency of interests and perseverance of effort (Duckworth and Quinn, 2009). To date, grit has been tested across many age groups and countries; however, the literature has conflicting conclusions regarding the strength of the relationship between grittiness and academic performance (Credé, Tynan and Harms, 2017).

A number of studies have found a positive link between grit and academic performance (e.g. Duckworth and Quinn, 2009; Burks et al., 2015; Hobden and Hobden, 2015; Alan et al., 2019; Wills and Hofmeyr, 2019). Some authors have isolated the two facets of grit to investigate their impact on academic success. Wolters and Hussain (2015) find that neither perseverance nor consistency significantly predicts a students' current achievement; while Muenks, Wigfield, Yang and O'Neal (2017) notes that perseverance and overall grit significantly predict students' grades, although consistency does not affect academic outcomes. On the other hand, Beattie et al. (2018) finds no significant difference in grit levels between students who achieve distinctions and those who fail a course. Most of these studies use cross-sectional data, with two using longitudinal data. Only one (Alan et al., 2019) presents causal evidence, using a randomised controlled trial design.

Two studies in South Africa have also used the Grit-S questionnaire to predict grade outcomes. Wills and Hofmeyr (2019) find that gritty pupils in rural fee-free primary schools are more academically resilient and therefore achieve better academic scores. First-year Technicon students' overall level of grit, as well as the perseverance of effort and

consistency of interest, have also been found to significantly affect academic performance in a positive way (Mason, 2018).

Research has shown that grit is malleable: Hoeschler, Balestra and Backes-Gellner (2018) create a longitudinal dataset by surveying the same participants over six years, the authors find that grit improves over this period. Park et al. (2018) shows that when teachers value scholars' effort and perseverance, this stimulates grit levels in students. Significantly, Alan et al. (2019) finds, in a randomised controlled trial, that supplementing a primary school curriculum by teaching pupils with the use of animated videos and classroom activities to set goals, to work hard to achieve goals, and to deal with setbacks led to improvements in mathematics scores. For example, one video shows a discussion: one student states that their setbacks are because they are not intelligent. The second student responds with a different perspective stating that setbacks are inevitable and an opportunity to learn. These authors conclude that grit (particularly perseverance) can be learned. They note that mathematics scores of the group receiving the intervention remained higher even 30 months after the intervention, suggesting some persistent changes in perseverance.

Extrinsic (engaging and completing tasks to benefit from external rewards) and intrinsic (engaging in tasks that are enjoyable and internally rewarding for oneself without receiving an external reward) motivation have been studied in recent literature. Intrinsically motivated students have been found to perform better academically than extrinsically motivated students (Karlen et al., 2019). Afzal et al. (2010) argues that this is because intrinsically motivated students tend to be more passionate about learning, which yields higher academic results. Beattie et al. (2018) asks open-ended questions in a survey relating to future goals and qualities that students admire in themselves, and finds that high academic performers are more likely to be intrinsically motivated, while extrinsic motivation is common among students with lower grades. As with grit, research has shown that intrinsic motivation for a task can change over time, for example interest and intrinsic motivation is increased when students are encouraged to focus on self-determination, competence and self-realisation in a task (Schwartz and Waterman,

2006). In another study at a tertiary education level, teaching students how to set long-term goals and encouraging students to pursue degrees that align with their lifelong goals were reported to stimulate students' intrinsic motivation (Wolters and Hussain, 2015).

Much of the existing literature focuses on individual factors affecting academic success in isolation. Very few studies consider more than one of these factors together. Beattie et al. (2018) analyse motivation and personality traits of students to determine academic success. However, this study uses separate student samples, such that their research does not allow examination of relationships between students' motivations and personality traits. In a study looking at motivation and grit, Zhao et al. (2018) notes that intrinsic motivation has a positive relationship with grit and extrinsic motivation has a negative correlation with grit. Comparably, Karlen et al. (2019) find that the perseverance aspect of grit is positively correlated with intrinsic motivation and negatively related to extrinsic motivation.

In this paper, we investigate whether grit and intrinsic motivation have a positive impact on grades in a sample of university students, something which does not appear to have been studied in the South African context. Since both traits can be fostered, it may be beneficial to supplement the South African curricula with initiatives to promote these traits to assist student success. Only one other study considered the grades and grit relationship at the tertiary education level. This study uses a small sample of 121 students, and Mason (2018) notes that the paper does not include any factors affecting academic success. We build on these findings by investigating the impact of motivation type on grades, using a larger sample size and including controls for high school class size, matric average grade and demographics.

3 Methodology

3.1 Participants

First year economics students at the University of Pretoria, South Africa, were invited to participate in a survey on factors that affect academic grades.² The invitation to participate was published as an announcement in the first year economics course on the university's Blackboard learning management system platform, 'ClickUP'. The students were incentivised to take part in the survey by entering the participants into a draw where two randomly selected participants each won R250. The students were aware that participation was completely voluntary; therefore, if the student participated, it did not influence their course grade in any way. Although students were asked to provide a student number with their responses (allowing us to link their responses to their grades), students were assured that all data would be stored and analysed anonymously.

432 students responded to the survey. The total number of students enrolled in the first-year economics course was 2807, meaning that our sample was approximately 15% of the total population. Since we do not have detailed demographic or high school details for the students who did not respond to the survey, we are unable to test for possible selection bias in this sample. We have missing grade information for eleven participants and one respondent did not answer the question related to the preparedness of their high school teacher. This reduces the sample to 420 participants, of whom 284 are female and 136 male. Of the participants 96.1% chose to disclose their race as follows: 44.9% are Black, 2.3% are Coloured, 8.1% are Indian/Asian, 1.6% are Multiracial and 39.1% are White. These race demographics align well with those of the first-year economics group as a whole: 48.6% are Black, 3.0% are Coloured, 7.6% are Indian/Asian and 40.6% are White.

²The first-year economics module is a compulsory module for all students enrolled in a degree in the Economic and Management Sciences faculty. This group therefore includes students from a variety of backgrounds, as well as those studying for economics degrees.

3.2 Survey

The survey had five sections; the first was the Grit-S survey (Duckworth and Quinn, 2009). The second section consisted of open-ended questions, where participants were asked about their motivations for attending university, for example, we asked: "Why did you decide to attend university?" and "Why do you need to succeed in achieving your degree?". These questions were posed to obtain information about the student's motivation type. Third, we inquired about the student's high school experience, specifically the participant's matric experience. To account for the variations occurring in the schooling environment, we asked about the number of students that were in their grade 12 classes and the level of preparedness of their teachers. We also asked about students' matric grade. The last section included demographic questions.

3.3 Data

Before starting any data analysis, we linked the students' questionnaire responses to their academic performance in the first-year economics course by using student numbers. Once the data of participants' grades and questionnaire responses had been combined, the student number identifier was deleted. Therefore, the data are anonymous.

3.3.1 University performance

The assessments for the semester consisted of three class tests, two semester tests and one exam. First, for each type of assessment, an average mark was calculated; then, the mean of the class test average, average semester-test mark, and exam mark form a weighted average Grade variable.

3.3.2 Personal characteristics

The grit variable ranges from a value of 5, corresponding to the individual being very gritty, to a value of 1, indicating that an individual is not at all gritty.

We created our motivation variable using text analysis³ of responses to the question, "Why did you decide to attend university?".⁴ The phrases associated with each type of motivation for the text analysis were taken from three motivation surveys: "The University Student Motivation and Satisfaction Questionnaire version 2" (Neill, 2004); "The Situation Motivation Scale" (Guay et al., 2000) and "The Academic Motivation Scale" (Vallerand et al., 1992).

Since many students wrote their responses using different words from those used in the surveys, we also created a second list of words using the surveys as a guideline, in an attempt to capture the type of motivation more accurately in an open-ended question context. We used synonyms and alternative phrases similar to those in the surveys in this list. This revised list is available in Appendix A.

We counted the number of words in a student's response that matched the published motivational surveys of the intrinsic and extrinsic type to create a continuous motivation variable "Intrinsic % (survey)" and "Extrinsic % (survey)". Next, the same response was evaluated using the revised list containing synonyms and rephrased statements to create the variable "Intrinsic % (revised)" and "Extrinsic % (revised)".

Lastly, we created an indicator variable noting whether a student claimed to be hardworking. The students were asked, "Which personality trait(s) help you to succeed academically?" and responses were analysed based on whether they included the word "hardworking".⁵

3.3.3 High school experience

Section 3 of the survey collected information regarding participants' high school experience. Participants were asked about the number of students that were present in their matric classes as a possible proxy for the quality of high-school education. Angrist and

³Please see the Appendix for additional details on the text analysis approach.

⁴Our hope had been to include a second question in determining the motivator type: "Why do you need to succeed in achieving your degree?" However, we noted that a number of students interpreted the question not as intended. Responses, for example, contained information about degree requirements. We therefore excluded this question when creating the motivational variables.

⁵The hardworking variable did not consider any synonyms. When using the appropriate synonyms from the Oxford English Dictionary, the variable identifies most of the responses from the student population. Synonyms eliminate most of the variation highlighted by the indicator variable.

Lavy (1999) note a positive correlation between smaller class sizes and academic achievement. The authors suggest that reducing class size limits from 31 pupils to 25 will improve student grades. Based on this research, we used 25 students as the cut-off for our class size dummy variable. 38.7% of participants reported class sizes with 25 or fewer pupils.⁶

Teacher preparedness captures information regarding the students' perceived quality of high school education. This variable ranges from [0; 10] where a value of 10 signals quality education, specifically, the teachers were prepared for lessons and taught new content regularly. The overall average rating was 8.139; therefore, on average students feel that high-school teachers were prepared and new material was taught.

Lastly, the participants' overall matric average grade ranges from zero to four.⁷ If participants' achieved an average between 50% and 59%, then the variable was coded as zero; while if the participant scored higher than 90%, the variable was coded as four. When considering the entire survey sample, the average self-reported matric mark is roughly 70%.

3.3.4 Demographics

The survey sample consists of 32.4% males and 67.6% females.⁸ Participants could identify their race as Asian, Black, Coloured, Indian, Multiracial, White, or choose not to disclose this information. The sample consists of 44.9% Black participants. Since this is the majority, this is the reference group for the indicator variable. All remaining ethnicities are grouped, namely, Asian, Coloured, Indian, Multiracial, White and participants who did not disclose their race. These six races are grouped under the umbrella term of

⁶In South Africa, many of the public schools are fee-paying schools, where school fees are used in part to hire additional teachers and reduce student: teacher ratios. The class size variable is therefore a likely proxy for school quality.

⁷South Africa reports continuous grades (percentages) for matric averages, but also uses symbols representing grade ranges. Since students are more likely to remember the symbol than the exact grade, and since this item was self-reported, we requested the symbol/range.

⁸Our sample had a larger proportion of female respondents than the class from which respondents were recruited. This introduces concerns about selection bias which we address by running the regressions separately by gender as a robustness check of our findings. Although coefficients were smaller and not always significant for males, the results for both groups are similar to our overall findings. These detailed results are available from the authors on request.

“Other”.⁹

Due to the Coronavirus pandemic, South Africa implemented a national lockdown starting on 27 March 2020. This lockdown suspended in-contact classes. The University of Pretoria transitioned to an online platform where lectures, course material and tests were available online.¹⁰ Therefore, a stable internet connection was necessary for easily obtaining course materials and writing tests, and the absence of stable internet might have impacted students’ grades. Only 75% of participants had access to a stable internet connection. Finally, at the University of Pretoria, English is the language of instruction in teaching and tests for the economics course. A value of one denotes that the student is fluent in English, while a value of zero indicates that a student did not recognise English as one of their fluent languages. Most of the participants (94.9%) report being fluent in English.

The descriptive statistics are summarised in Table 1.

⁹Due to the small sample size of Asian, Coloured, Indian, Multiracial and White ethnicities, these races were grouped without affecting variable significance or magnitude in the regressions.

¹⁰The university made laptops and data available for students that were in need financially to ensure that all students were able to continue with their studies. This provision meant that all students who wanted to would have been able to partake in the survey too.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
University performance					
Grades	420	69.368	12.27	30.602	95.093
Personal characteristics					
Grit	420	3.46	.662	1.75	5
Consistency	420	3.039	.843	1	5
Perseverance	420	3.882	.672	1.75	5
Intrinsic % (revised)	420	7.396	12.176	0	100
Extrinsic % (revised)	420	24.143	17.871	0	100
Intrinsic % (survey)	420	26.111	18.183	0	100
Extrinsic % (survey)	420	46.211	20.221	0	100
Hardworking not mentioned	420	.645	.479	0	1
Hardworking	420	.355	.479	0	1
High school experience					
25 or less students	420	.388	.488	0	1
26 or more students	420	.612	.488	0	1
Teacher preparedness	420	8.15	1.799	0	10
Matric average	420	2.093	.793	0	4
Demographics					
Asian	420	.007	.084	0	1
Black	420	.443	.497	0	1
Coloured	420	.024	.153	0	1
Indian	420	.071	.258	0	1
Multiracial	420	.014	.119	0	1
White	420	.4	.49	0	1
Undisclosed	420	.04	.197	0	1
Unstable internet	420	.252	.435	0	1
Stable internet	420	.748	.435	0	1
Not fluent in English	420	.048	.213	0	1
Fluent in English	420	.952	.213	0	1
Male	420	.324	.468	0	1
Female	420	.676	.468	0	1

3.4 Hypotheses

Based on findings from the existing literature, we test the following hypotheses:

- (1) Gritty students are expected to achieve better grades relative to non-gritty students (Alan et al., 2019; Burks et al., 2015; Duckworth and Quinn, 2009; Hoeschler et al., 2018; Mason, 2018; Wills and Hofmeyr, 2019).
- (2) Intrinsically motivated students are expected to outperform extrinsically motivated

students (Afzal et al., 2010; Karlen et al., 2019).

(3) When evaluating the relationship of grit and motivation together, we anticipate that both grit and intrinsic motivation would be positively correlated with grades.

(4) Lastly, we expect intrinsic motivation to positively predict grit. (Karlen et al., 2019; Zhao et al., 2018).

3.5 Data Analysis approach

3.5.1 Do grit and motivation predict grades? (Hypotheses 1-3)

In order to understand how grittiness and motivation impact academic performance at university level, we estimate the following model, using the Ordinary Least Squares (OLS) method¹¹:

$$grade_i = \alpha_0 + \beta_1 grit_i + \beta_2 intrinsic_i + \gamma \mathbf{X}_i + \epsilon_i \quad (1)$$

Our *grit* variable ranges from 1 to 5, based on responses to the Grit-S survey. Our continuous *intrinsic* motivator variable displays the difference between the percent of intrinsic and extrinsic words used in a student’s response. The matrix of control variables \mathbf{X} includes the high school class size, a categorical matrix average and dummy variables relating to the stability of the individual’s internet, whether they are fluent in English and their race and gender.

3.5.2 Does motivation predict grit? (Hypothesis 4)

To better understand the relationship between grit and motivation, we investigate whether motivation impacts grittiness by estimating the following simple model¹²:

$$grit_i = \alpha_0 + \beta_1 intrinsic_i + \beta_2 hardworking_i + \gamma \mathbf{Y}_i + \epsilon_i \quad (2)$$

The *intrinsic* variable is a continuous measure of motivation calculated as the differ-

¹¹This model meets the Gauss Markov assumptions with the exception of homoscedasticity. To correct for this, we implemented robust standard errors.

¹²This model meets the Gauss Markov assumptions with the exception of homoscedasticity. To correct for this, we implemented robust standard errors.

ence between the percent of intrinsic and extrinsic words counted in a student's response. *Hardworking* is a dummy variable coded as 1 if the respondent spontaneously mentioned being hard working; and 0 otherwise. The matrix of control variables (\mathbf{Y}) includes the individual's matric average, how prepared their high school teacher was, the size of their matric classes, their gender and race.

4 Regression Results

4.1 Grit, Motivation and Grades (Hypotheses 1-3)

Table 2: OLS Estimates of the impact of grit and motivation on grades

	Dependent variable: Grades				
	(1)	(2)	(3)	(4)	(5)
Grit	3.713*** (0.97)		4.035*** (0.98)	1.854** (0.81)	1.701** (0.80)
Net Intrinsic % (revised)		-0.224 (0.36)	-0.588 (0.36)	-0.467 (0.28)	
Net Intrinsic % (survey)					-0.306 (0.35)
HS students > 25				-2.799*** (0.92)	-2.797*** (0.93)
Matric average				6.810*** (0.64)	6.819*** (0.64)
Other				4.220*** (1.08)	4.187*** (1.09)
Female				-3.339*** (0.94)	-3.244*** (0.95)
Stable Internet				2.468** (1.14)	2.484** (1.15)
Fluent in English				7.414*** (2.63)	7.320*** (2.62)
constant	56.519*** (3.34)	69.370*** (0.60)	55.413*** (3.39)	41.417*** (3.85)	41.959*** (3.83)
Observations	420	420	420	420	420
Adj. R Square	0.038	-0.002	0.041	0.417	0.415

Notes:

Standard errors in parentheses.

Statistical significance indicators: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Grit is variable ranging from 1 to 5 based on the Grit-S survey responses. *Net intrinsic %* relates to the difference between intrinsic and extrinsic words used in a student's response for the *revised* or *survey* variable. *HS students > 25* returns one when the high school class size is greater than 25 and zero otherwise. *Matric average* is a categorical variable ranging between zero and four, where a one unit increase equates to a 10% difference in grade. *Other* indicates non-black ethnicities with value one and value zero for black participants. *Female* returns one for female participants, and zero otherwise. *Stable internet* indicates one when the participant reports stable internet and zero otherwise. *Fluent in English* shows one when the participant is fluent in English and zero otherwise.

Table 2 reports on the relationship between grit and motivation type with a student's university grade. In line with hypothesis 1, we note that grittier individuals perform

better academically relative to the less-gritty participants; this is evident in column 1 as a one unit increase in grit will increase grades by 3.71 percentage points, *ceteris paribus*.¹³

Hypothesis 2 is tested in column 2 which shows that intrinsically motivated students do not perform significantly differently from extrinsically motivated students. This result remains when using the survey measure of the motivation variable.¹⁴ This relationship differs from the prediction of our second hypothesis. Karlen et al. (2019) find a positive relationship between intrinsic motivation and grades. The difference between our finding and that of Karlen et al. (2019) could be related to differences in the focus of our motivation questions: Karlen et al. (2019) asks about students' motivation specific to an academic task (which might be more closely associated with grades), while we use Beattie et al. (2018)'s broader question about the student's motivation for attending university. We chose this question to obtain a broader understanding of a student's motivation.

When including both personality factors as predictors of grades, we note that grit continues to have a significant positive effect on grades, while intrinsic motivation does not significantly predict grades.

Columns 4 and 5 include controls for high school class size, matric average grade, race and gender as well as stability of the internet connection used for online learning, and fluency in English. The inclusion of these controls significantly improves the predictive power of the regression. While many of these underlying variables have higher predictive power than the grit measure, it is encouraging to note that the relationship between grit and grades persists with these controls, although the size of the coefficient is reduced. When all of our control variables are included, a one unit increase in grittiness is associated with a 1.7 percentage point change in grade. Since a 10% difference in previous matric grade is associated with a 6.8 percentage point change in university economics grade, the association of grit with university grades is relatively small compared to the predictive value of high school grades.

¹³When considering students with failing or borderline grades separately from students with stronger grades (55%) we find that this relationship does not hold, however, this sample size is small.

¹⁴For the motivation variable, similar results are found when using an indicator motivation variable. This variable would be intrinsic and return a value of one when the difference between intrinsic and extrinsic words is positive. These results are available on request.

4.2 Does Motivation type predict Grit? (Hypothesis 4)

Table 3: OLS Estimates of motivation on grit

	Dependent variable: Grit %			
	(1)	(2)	(3)	(4)
Net Intrinsic % (revised)	1.804*** (0.00)		1.502*** (0.00)	
Net Intrinsic % (survey)		1.435*** (0.00)		1.332*** (0.00)
Hardworking			5.969*** (0.00)	6.377*** (0.00)
Matric average			2.528*** (0.00)	2.578*** (0.00)
Teacher preparedness			1.347** (0.04)	1.317** (0.05)
HS students > 25			2.341* (0.06)	2.304* (0.07)
Female			-2.038 (0.11)	-2.441* (0.05)
Other			1.892 (0.13)	2.085* (0.10)
Constant	69.186*** (0.00)	69.179*** (0.00)	60.663*** (0.00)	60.594*** (0.00)
Observations	420	420	420	420
Adj. R Square	0.047	0.021	0.144	0.130

Notes:

Standard errors in parentheses.

Statistical significance indicators: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Grit is variable ranging from 1 to 5 based on the Grit-S survey responses. *Net intrinsic %* relates to the difference between intrinsic and extrinsic words used in a student's response for the *revised* or *survey* variable. *HS students > 25* returns one when the high school class size is greater than 25 and zero otherwise. *Matric average* is a categorical variable ranging between zero and four. *Other* indicates non-black ethnicities with value one and value zero for black participants. *Female* returns one for female participants, and zero otherwise. *Stable internet* indicates one when the participant has stable internet and zero otherwise. *Fluent in English* shows one when the participant is fluent in English and zero otherwise.

Table 3 displays how the continuous intrinsic motivation variable predicts the grittiness of an individual using an OLS regression. Columns 1 and 3 evaluate grit when the motivation variables are created using the revised construct. This intrinsic variable predicts higher levels of grit: in column 1, if net intrinsic motivation increases by 1% this improves grit by 1.80%, ceteris paribus. This positive relationship between intrinsic motivation and

may also suffer from some omitted variable bias, since we cannot fully capture underlying ability or other unobservable characteristics that might be associated with both grit and academic performance.

Our results suggest that programs in South African schools which aim to foster grit could help to improve students' grades. Our findings show that having teachers who are well prepared predicts higher grit levels in students. This is a reminder of the importance of training and hiring teachers who will appropriately model hardworking and diligent behaviours. Training teachers in South Africa to encourage these behaviours in students could impact student grades by improving grit levels. Further, intrinsic motivation can be stimulated by encouraging university students to study degrees which align with their lifelong goals. Increased intrinsic motivation might in turn increase grittiness.

These simple strategies might have a positive impact on students' grades, by teaching them the importance of grit and perseverance. Given the grade differences from different school types, particularly lower grades among those with bigger classes (often representing less wealthy schools), interventions focused on malleable personality traits which can help to close this grade gap between the privileged and the less privileged are particularly important in South Africa.

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6 Appendix

6.1 Text analysis approach

Text analysis was conducted in Python using the regular expression, stop words and porter stemmer packages.

The first part of text analysis was to edit the responses; one needed to tokenise the text by breaking up sentences into words, correct any spelling errors, remove all punctuation, remove stop words and lastly, stem the words (Korstanje, 2020). The purpose of stemming is to group responses with the same meaning but written differently.

To determine whether the participants' responses demonstrated intrinsic or extrinsic motivation, the list of words formed looped through a student's response and counted the number of matched words between the intrinsic survey key words and the extrinsic survey key words. Matching the words from the developed surveys to each student's response allowed us to create an intrinsic and extrinsic measure for each student.

Appendix A: Revised list of key words linked to published survey themes

Table 4: Extrinsic list of words: related to career and money

Survey	Survey Statement	Rephrased statement
USM	to gain valuable skills for my career.	For my future; For opportunities
USM	because it's a better alternative than working.	To have a sustainable livelihood
USM	to enhance my job prospects.	To get a degree; For future success
USM	to avoid being unemployed.	To have a luxurious life; I need money as I have expensive taste
USM	in order to get the qualification.	To obtain qualifications; To gain skills; To further my studies
USM	because it gives me something to do.	To get a job; To be financially secure
USM	because it will help set up my future career.	For my career; To gain relevant knowledge for my career
USM	so I can get a better job.	For my profession; To graduate; To get ahead in life To have a comfortable life; It will open doors It provides financially ; To pursue my career To get a job that pays enough; To do well in life To earn more money; To have a better life To open a business; To have a good pay For employment; To have recognition from degree To have a legacy; To set myself apart from others To cover the costs of univeristy; To be self sufficient I want to be a CA; To stand out from the rest

USM = The University Student Motivation and Satisfaction Questionnaire version 2 by Neill (2004)

Table 5: Extrinsic list of words: related to social aspects

Survey	Survey Statement	Rephrased statement
USM	because its fun place to be.	To develop different views; To meet new people
USM	because I enjoy the social life.	To experience new things; To live in a new city
USM	because of the social opportunities.	For the experience; For independence
USM	because I enjoy the social environment.	For exposure to new things; To make connections
USM	because its a great place to develop friendships.	To experience university life; To have fun Great way to start my adult; To socialize; For networking To make new friends; To get friends To live the life of university student

USM = The University Student Motivation and Satisfaction Questionnaire version 2 by Neill (2004)

Table 6: Extrinsic list of words: related to external pressures

Survey	Survey Statement	Rephrased statement
USM	of social expectations from those around me.	To make my parents proud; It is the right thing to do
USM	it seems to be the recommended thing to do.	Getting an education is big in family
USM	because I don't have any better options.	They had course; I have no talents
USM	because it would disappoint other people if I didn't.	My parents forced me; I did not have a choice
USM	because others expect me to get a degree.	It wasn't a second thought
USM	because other people have told me I should.	There were no alternatives
USM	because I don't know what else to do.	I did not have alternative; University is a rule of thumb
		University is a norm; University is non-negotiable
		Going to university is playing it safe
		It is the smartest thing to do after high school
		My parents told me to go to university
		I enrolled in university due to indecisiveness
		University is the next step; University is the only way
		It wasn't really a choice; I need to please my parents
		Academics is strong suit; Academia is where my strengths lie
		It is the only path; University is the only option
		It was non-negotiable; It is my responsibility to succeed
		To make them proud; To not disappoint my parents
		I have no other option; I don't want to be failure
		University will be a morale boost
		Failure isn't an option so I go to university
		Going to university will prevent feelings of failure

USM = The University Student Motivation and Satisfaction Questionnaire version 2 by Neill (2004)

Table 7: Intrinsic key word list: related to Altruism

Survey	Survey Statement	Rephrased statement
USM	because I want to be more useful to society.	I want to be useful to society
USM	because I want to improve the world situation.	I want to help society
USM	because I genuinely want to help others.	I want to change my family's state
USM	because I want to help solve society's problems.	I want to help my community
USM	because I want to contribute to society.	I want to change my family's situation
		I want to give to family
		I want to give to friends
		I want to help my family financially
		I want to help pave the way
		I want to serve my community
		I want to empower greater society
		I want to have a positive impact on society and the economy
		I want to sustain myself and family
		I want to put bread on the table for my family
		I want to get rid of poverty
		I want to be a good example to community
		I want to motivate peers in village
		I want to improve home situation
		I want to start a charity
		I want to start an NGO
		I want to inspire others
		I want to break the poverty cycle
		I want to help those around me
		I want to make the world a better place

USM = The University Student Motivation and Satisfaction Questionnaire version 2 by Neill (2004)

Table 8: Intrinsic key word list: related to self interest

Survey	Survey Statement	Rephrased statement
USM	because I love learning.	for knowledge
USM	because I want to explore new ideas.	It's my dream
USM	because I want to challenge myself.	To broaden my mind
USM	for my personal growth and development.	To develop my cognitive ability
USM	to understand myself better.	Because this is my passion
SMS	because I think this activity is interesting	This subject excites me
SMS	because I think this activity is pleasant	contributor
SMS	because this activity is fun	I love learning
SMS	because I feel good when doing this activity	To become educated
AMS	Because I experience pleasure while learning new things	It's my personal challenge
AMS	For the pleasure when discovering new things never seen before	It gets me out of bed
AMS	For the pleasure that I experience in broadening my knowledge	To unlock my full potential
AMS	Because my studies allow me to learn about things that interest me	To unlock potential
AMS	For the pleasure I experience while surpassing myself in my studies	To pursue my purpose
AMS	To surpass myself in a personal accomplishments	To help myself
AMS	For the satisfaction of accomplishing difficult academic activities	To make myself proud
AMS	Because it allows me to experience a personal satisfaction	To be a well rounded person
AMS	Because I really like going to school	To learn skills
AMS	Because for me, school is fun	To learn other important skills
AMS	For the pleasure of discussions with interesting teachers	To be a better person
AMS	For the 'high' feeling that I experience while reading about interesting subjects.	To maximise academic potential
		To understand the deeper context
		For self fulfilment
		Learning interests me
		To feel satisfied with my own personal goals
		To prove to myself that I can graduate

USM = The University Student Motivation and Satisfaction Questionnaire version 2 by Neill (2004)

SMS = The Situational Motivation Scale by Guay et al. (2000)

AMS = The Academic Motivation Scale by Vallerand (1992)