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Grit, motivational belief, self-regulated learning (SRL), and academic achievement of civil engineering students

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ABSTRACT

The influence of grit on engineering student's achievement has been understudied. The association between grit, self-regulated learning (SRL), and academic achievement in civil engineering students was investigated using correlation and regression analysis. One hundred and one civil engineering students from various nationalities completed a self-report questionnaire that contained the Grit 12-item scale and the forty-four questions on motivational beliefs and self-regulated learning practices (MSLQ). Four of the five SRL variables were predicted by perseverance of effort: intrinsic value, self-efficacy, cognitive strategy use, and self-regulation. Initially, perseverance of effort predicted the current grade point average (GPA), but it was no longer a predictor after including SRL indicators. Consistency of interest was a predictor of cognitive strategy usage, but it did not affect students' academic achievement. GPAs were also predicted by student self-efficacy and age. The connection between academic accomplishment and grit is mediated by SRL engagement. Students' perceived competency and confidence in completing their degree were shown to be major determinants of their GPA. Furthermore, motivational beliefs had a greater effect on students' GPAs than grit did. In the majority of the study's constructs, female students outperformed males. GPAs were higher among younger students than among their older peers.

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Introduction

Educators often question why some students capitulate when confronted with academic adversity while others overcome and persevere toward achieving better grades. Researchers have explored various variables relating to elements that promote and correlate with academic achievement (Winne and Nesbit 2010). However, improvements in students' overall performance still fall short of ideal. Over the past two decades, researchers have advocated self-regulated learning (SRL) as a primary factor for understanding, evaluating, and improving students' performance (Zimmerman and Schunk 2008; Wolters and Hussain 2015).

Self-regulated learning, also known as lifelong learning, is an increasingly sought goal of engineering education (Ambrose et al. 2010) because self-regulated learners are capable of acquiring and retrieving new information and skills on their own, and in a problem-based field such as engineering, ownership of one's learning could prove advantageous (Wallin and Adawi 2018). The self-regulated learning (SRL) process requires students to monitor their progress, assess their learning independently, and plan both their short- and long-term goals for learning and self-motivation. In conjunction with self-confidence, emotional stability, cognitive ability, creativity, emotional intelligence,

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charisma, creativity, and physical attractiveness, self-regulated learning has provided researchers with a better understanding of students' academic achievement differences (Duckworth et al. 2007; Shechtman et al. 2013). Mega, Ronconi, and De Beni (2014) and Wolters and Hussain (2015) believe that integrating SRL with individual dispositions may allow for further understanding of academic performance than these traits indicate individually, particularly as some traits tend to be more vital for particular vocations than others. For example, extraversion may be more relevant to a sales business career but less critical for engineering careers; as Burton and Dowling (2009) noted, engineering students scored lowest on extroversion compared to any other personality or cognitive trait.

Nonetheless, some traits might be crucial for success, regardless of the field (Duckworth et al. 2007). Duckworth et al. (2007) suggest that the non-cognitive trait grit is shared among the most outstanding leaders in every domain. Grit is defined as perseverance and passion for long-term goals (Duckworth et al. 2007). A recent meta-analysis concluded that perseverance is a moderate predictor of success on its own, but it is considerably greater when passion is high - a moderating effect best evaluated using regression-based models (Credé 2018). Duckworth et al. (2007) showed that laying the groundwork for a career requires detailed preparation in the form of grit, as grit could be a predictor of success over and beyond talent (Duckworth, Quinn, and Seligman 2009). However, the literature is inconclusive as to whether grit becomes a better predictor of success among individuals who have the required level of innate ability or self-regulation to excel at a particular task. For example, becoming a professional soccer player may require high levels of innate foot and eye coordination talent combined with high levels of grit; either one alone is not sufficient to achieve excellence. This possibility has been argued by Duckworth, Eichstaedt, and Ungar (2015) for a polynomial relationship between ability and grit. In other words, grit and ability might both be necessary but not sufficient conditions for success and performance (Credé 2018).

Self-regulated learning, grit, and academic achievement are essential factors in this study; the objectives are derived based on cognitive and non-cognitive traits, including student differences. Grit was also explored to determine whether it could predict students' engagement in SRL: cognitive, metacognitive, self-efficacy, intrinsic value, test anxiety, and motivation. Accordingly, the final objective assesses grit and SRL variability, gender, and students' current grade point average (GPA) range. Based on previous studies, such as Duckworth et al. (2007), Wolters and Hussain (2015), Burkhart et al. (2014), Martin et al. (2018), and Martín and Sorhaindo (2019), several hypotheses have been investigated: Grit influences self-regulated learning (SRL) to mediate the achieved GPA range; Grit and SRL vary between the academic year of study; Grit and SRL differ with gender and age.

As grit's influence on students' performance is underexplored in engineering (Direito, Chance, and Malik 2021), addressing this deficiency will allow researchers to learn whether grit is correlated or a causal factor in self-regulation and why some students have attained better grades than others. The framework used for Grit and SRL's concepts would help understand academic achievement differences among undergraduate civil engineering students. Using the framework provides more insight into the relationship between grit and self-regulated learning, and hence, can be regarded as a measurement for evaluating these factors. Therefore, this study provides the benefit of explaining what future engineering students should have as qualities necessary to excel.

Grit and performance

Grit has been investigated in both educational and workplace domains. Limited applications in education have been seen through various studies conducted on perseverance and passion for long-term goals (Duckworth et al. 2007), comparative measures of grit, tenacity and perseverance (Christensen and Knezek 2014), and grit as a marker of residents at risk of attrition (Burkhart et al. 2014). The idea that grit is associated with high achievement came about through interviews with professionals in investment banking, painting, journalism, academia, medicine and law. When these professionals were questioned about what made the difference between themselves and others, they cited grit (Duckworth et al. 2007). Duckworth et al. (2007) hypothesised that grit, more than self-

control and conscientiousness, distinguished remarkable individuals. The authors suggested a measure of grit meeting four criteria for evaluations that include evidence of psychometric soundness, low likelihood of ceiling effects in the high-achieving population, face validity for adults and adolescents pursuing goals in various domains, and most importantly, a precise fit with the construct of grit (Duckworth et al. 2007). Based on these criteria, they developed a 12-item survey known as Grit-O to measure grit's construct divided into two subscales, consistency of interest and perseverance of effort. Later, Duckworth, Quinn, and Seligman (2009) developed a shorter eight-item survey (Grit-S) version. In previous studies assessing grit, surveys such as the Grit short-scale (Duckworth and Quinn 2009) and the Computer Attitude Questionnaire (CAQ) (Christensen and Knezek 2001; Knezek and Christensen 1996) were employed.

Since grit has been defined as perseverance and passion for long-term goals of individuals (Duckworth et al. 2007), it has been considered different from other personality traits, and therefore its use in analysing academic outcomes could be significant (Wolters and Hussain 2015). This significance in outcome is due to the insufficiency of setbacks, distractions and other forms of interference to phase the student who possesses high grit levels. A population sampled from the military shows that grit is connected to educational attainment, college grades, self-control, and success (Duckworth et al. 2007). Investigations by MacCann and Roberts (2010) found that perseverance and effort played a significant role in student success, specifically academic readiness. The research also shows that although a reasonable amount of work has been done on grit, a considerable challenge is still present in linking grit specifically to student academic achievement. Wolters and Hussain (2015) expressed that the field was still seen to be limited and inconsistent since two of the studies conducted, (MacCann and Roberts 2010) and (Strayhorn 2014), produced conflicting results. In addition, the connection between self-regulation and grit is absent from studies exploring engineering students.

Self-regulated learning and academic performance

Self-regulation of cognitive and behavioural aspects of learning is essential for students' academic performance in the classroom (Corno and Mandinach 1983). According to Zimmerman (1990), self-regulated learners approach tasks with confidence, diligence and resourcefulness. Unlike their passive classmates, they seek out information when required and take the necessary steps to master tasks despite obstacles such as distracting study conditions, confusing teachers or obscure textbooks. Self-regulated learning involves specific processes that often differ based on researchers' theoretical perspectives (Borkowski et al. 1990; Corno 1989; Zimmerman 1990). This difference has led to various definitions of self-regulated learning, but three components are essential for academic performance (Pintrich and De Groot 1990). The first component relates to the common factors among assessed students: metacognitive, motivationally, and behaviourally active participants in their learning (Zimmerman 1986).

Regarding metacognitive strategies, self-regulated learners plan, set goals, monitor and modify their cognition at various points during acquisition (Brown et al. 1983; Corno 1986; Zimmerman and Pons 1986). These learners display high self-efficacy, self-attributions and innate task interest (Borkowski et al. 1990; Schunk 1986; Zimmerman 1985). From a behavioural perspective, these learners select, structure and create environments that enhance learning (Henderson 1986; Wang and Peverly 1986; Zimmerman 1986, 1990). The second component deals with students' management and control of effort in carrying out classroom tasks; for example, those students who persist in challenging tasks or ignore surrounding distractions, maintain their mental commitment and improve their performance (Corno 1986; Corno and Rohrkemper 1985). A third feature of the definition of self-regulated learning that some researchers have included in their conceptualisation is an indication of how and why students choose to use particular strategies or responses to learn, remember and understand information (Corno and Mandinach 1983; Zimmerman and Martinez-Pons 1988).

This understanding has led to theories surrounding self-regulated learning, treating student learning and motivation as dependent processes and further implies that they cannot be understood as separate entities. According to Zimmerman (1989), self-regulated learners are not just aware of their learning outcomes, they proactively seek out other ways of learning. They formulate activities that promote self-evaluation and self-improvement, such as personal practice sessions (Zimmerman and Pons 1986), techniques such as problem-based learning and inquiry-based learning, which encourage students to take ownership of their learning (Kuh 2008). As a result, they are self-motivated by setting higher learning goals to achieve previous goals (Bandura 1989). Hence, self-regulated learning involves more than a student's ability to adapt and carry out their learning responses to new or varying negative feedback conditions. It also includes an enthusiastic approach to benefiting from learning activities. Thus, students will not completely benefit from student-centred teaching if they do not view learning as an active process in which information is created and co-built (Wallin and Adawi 2018).

Martin et al. (2018) and Patrick, Ryan, and Kaplan (2007) showed that the use of self-regulated strategies was more common among students who received feedback from their teachers and peers. The feedback conveyed to students is useful in providing information on components that are well done, and how they can improve (Labuhn, Zimmerman, and Hasselhorn 2010) and the steps they can take to optimise their work (Hattie and Timperley 2007). Therefore, using self-regulated learning in conjunction with progress feedback allows students to increase their academic achievement (Brookhart 2011). Unfortunately, students do not always well receive or understand feedback because previous learning experiences are affected by epistemological ideas and learning conceptions (Pintrich et al. 1993). It is crucial to determine whether students' epistemological views and learning concepts prevent them from participating in SRL (Wallin and Adawi 2018).

Grit, SRL and academic output

Dispositions, personality traits and other differences such as grit influence attitudes, beliefs, cognitive processes and behaviours that symbolise self-regulated learning (Bidjerano and Dai 2007; Komarraju, Karau, and Schmeck 2009). According to Wolters and Hussain (2015), no published empirical research has directly investigated these theoretical associations. Since no author has addressed academic outcomes and its relation to grit and self-regulation of engineering students, this will form the central focus of this work. The authors look specifically at the fact that there must be a reason why some individuals achieve better results than others considering that they are of the base acceptance criteria in a programme (Martín and Sorhaindo 2019).

The theoretical connection between grit, self-regulated learning, and academic achievement is not well established and has not been adequately researched. Wolters and Hussain (2015) explored whether grit can be used to predict college students' engagement in self-regulated learning. Their work found that perseverance of effort predicted only a priori achievement. Hence, students' engagement in SRL may function as a mediating pathway through which this aspect of grit is associated with enhanced academic outcomes. Evidence for the impact of grit on academic success has thus far been mixed (Whipple and Dimitrova-Grajzl 2021). The current research also explores this relationship and further determines whether grit and self-regulated learning together would form the basis of good performance in schools. Therefore, the following hypothesis is proposed:

H1: Grit influences self-regulated learning (SRL) in mediating the achieved GPA range.

Recent research within the same civil engineering department related to motivation by Martin, Sorhaindo, and Welch (2014), Martin et al. (2018), and Martín and Sorhaindo (2019) showed that sixty per cent of the students enrolled in the graduating class of 2012–2013 failed to complete the degree in the stipulated three years, and this was repeated in 2013–2014 and 2014–2015 with an increase of 13.3% in the latter year. Martin et al. (2018) confirmed that motivation quality and quantity change with cognitive development as students mature from one year to another. In

addition, several studies have examined students' grit levels throughout school years. Grit was much higher among first-year students than in prior academic years (Chen et al. 2015). Two further researchers (Senkpeil and Berger 2016; Sheridan and Carr 2017) discovered that year one students showed higher grit levels than later year students, but these differences were not statistically assessed (Direito, Chance, and Malik 2021). Lerner (2013) challenged these findings, showing that year two and three students were grittier on average than first-year students. Direito, Chance, and Malik (2021) contend that these interpretations are limited. It is, therefore, hypothesised as follows:

H2: Grit and SRL vary between the academic years of study.

Another deduction by Martin, Sorhaindo, and Welch (2014) was that females were more innately motivated throughout the three years than males and displayed better self-regulatory practices, such as goal setting and planning. Credé, Tynan, and Harms (2017) suggest gender differences in grit appear negligible. It is unclear whether the gender differences which exist for motivation will impact grit. Therefore, based on previous studies conducted by Christensen and Knezek (2014) and Zimmerman and Brogan (2015), it is expected that females would have higher grit and better self-regulation practices than males. Such assertions were also confirmed by San Choi and Loui (2015) and Bottomley (2015), who concluded that female students viewed themselves as harder working and diligent, and more likely to say they had overcome setbacks. Therefore, the following hypothesis is proposed:

H3: Grit and SRL differs between gender and age

Investigating these three hypotheses provides more evidence to substantiate previous research findings and show variations in civil engineering students' academic achievements.

Method

Procedure

The civil and environmental engineering department was established in 1961 and the BSc remains the only British accredited undergraduate programme serving the Caribbean region. Students in the three-year programme are typically enrolled from one of the 28 Caribbean member states, with the population understudy consisting of 134 undergraduates. Students were invited to complete the questionnaire voluntarily and were made aware of the study's purpose and that declining to participate would not adversely affect their marks. The principal researcher's contact was provided if concerns were outside the purview of the student researcher who administered the survey. Students enrolled in the department were provided with a questionnaire during Semester 2 of 2017-2018. Participants were contacted during class hours to maximise their participation. To ensure maximum responses, directly after distribution and filling out of the questionnaires, they were collected. Figure 1 shows the population demographics of the 101 respondents who originated from Trinidad (53%), Barbados (12%), St Vincent (1%), St Lucia (2%), Jamaica (4%), St Kitts (1%), Grenada (1%), Belize (2%), and 25% decline to indicate.

The questionnaire consists of seven demographic, 12-item Grit survey and 44-item modified Motivated Strategies for Learning Questionnaire (MSLQ) questions. The motivated strategies for learning questionnaire (MSLQ) is a self-reported tool used to evaluate college students' motivational orientations and use of various learning methods in a college course. The MSLQ is based on a broad cognitive perspective of motivation and learning methods, with the student portrayed as an active information processor whose beliefs and cognitions serve as key mediators of instructional input (Pintrich et al. 1993). To increase content validity, the questionnaire was adapted from the work of Duckworth et al. (2007) and Pintrich and De Groot (1990). Before distribution, a draft of the questionnaire was critiqued by two (2) lecturers and three (3) current students (one from each year group) to remove ambiguity and gauge administration time.

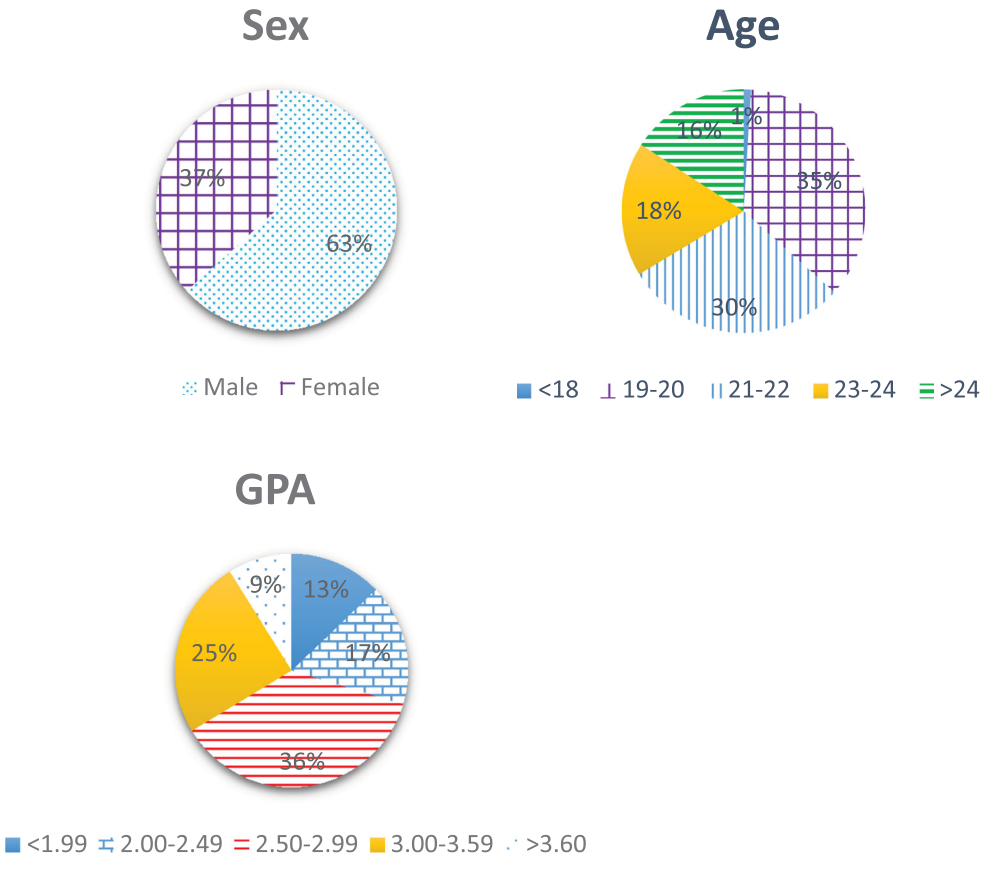

Figure 1. Population age, sex, and GPA distributions.

Rating scales can be selected solely based on the investigated psychometric test properties, nor is there one significantly superior to the others in terms of reliability (Lange et al. 2020). Different rating scales have a moderate to high correlation because they measure the same thing, and their results are consistently proportionate to one another (Lange et al. 2020). However, the scale chosen should embody the measurement objectives as further categorisation, granularity, or translation into a measurable context may not be necessary and is context-dependent. Chachamovich, Fleck, and Power (2009) suggest that limiting the number of categories on a scale enhances performance and improves the findings' accuracy. However, longer scales are statistically more trustworthy or granular than shorter ones, but higher-order scales plateau at 7 with no further increase beyond 11 (Finstad 2010). Comparing fewer objects is easier than comparing many because of the difficulties in resolving the intensity of feelings, measurement error, confusion from too many choices, and physical exhaustion, which induces laziness and random responses (Li 2013). Respondents' tiredness or the use of educated guesses leads to inaccurate data collection (Creswell 2002). While the traditional MSLQ is measured on a 7-point scale, such intensity issues when compared against a five-point scale are more evident in comparisons reflecting the understanding of individuals of what does six on a seven-point scale represents versus four on a five-point scale. The latter is intuitive and easily understood, whereas the former requires computation. Lee et al. (2002) investigated the cultural variations of scales and suggested that there are differences in difficulty in understanding, frequency of midpoint selection, admittance of positive emotion, and construct validity.

Likert-type and conventional measures to evaluate concepts such as self-efficacy have comparable reliability–error variance, offer identical levels of prediction, have similar component structure,

and have similar discriminability (Maurer and Pierce 1998). The Likert scale seems to offer an acceptable alternative way of assessing self-efficacy, which appears to be practical and provides empirical findings comparable to those obtained by other methods (Maurer and Pierce 1998). As earlier comparable work Martín and Sorhaindo (2019) and Martin et al. (2018) on motivation in the same jurisdiction uses a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), all scales for assessment in this study were similar. In Martin et al. (2018), the test-retest for the cross-sectional motivation of all years compared to the two and three-year longitudinal values indicated a strong positive correlation in predicting performance. The length of the scale, the type of scale, and the highlighted cultural differences warrant consideration for modifying the traditional questionnaire instruments used in this study.

The final survey instrument consists of three sections. The first section is related to the demographic characteristics of the respondents. The second section comprises twelve grit scale questions divided into two subscales, namely: consistency of interest and perseverance of effort. The final section consisted of forty-four modified items based on Pintrich and De Groot's (1990) motivational beliefs and self-regulated learning MSLQ instrument. Motivational beliefs were measured using 22 modified items from the study by Pintrich and De Groot (1990). These items were divided into three distinct motivational factors (self-efficacy, intrinsic value and test anxiety) as previously determined by Pintrich and De Groot (1990). To understand self-regulated learning strategies, both cognitive strategy use and self-regulation scales were assessed. Thirteen items represented cognitive strategy, and nine for self-regulation adopted from Pintrich and De Groot (1990) metacognitive and Zimmerman and Pons (1986) effort management items. The questions used in sections 2 and 3 are presented in Appendix A.

After collecting the answered questionnaires, the results were coded into Microsoft Excel 2016, and the numerical data was imported to SPSS 24.0 to conduct the statistical testing. In general, on a five-point Likert scale, a score of 4 or 5 represents an agreement, whereas a score of 1 or 2 is a disagreement. A high test anxiety score implies greater worry than a low score. Each scale gives the class average, as well as the lowest 25%, middle 50%, and top 25%. Those who scored in the bottom quartile had less desire, tenacity and application of learning techniques than the average student. A student who scored in the middle 50% was typical, whereas one who scored in the top 25% thought they were more motivated, possessed more grit or used more learning techniques. The study included 22 Year 1 students (21.8%), 40 Year 2 students (39.6%) and 39 Year 3 students (38.6%), giving a response rate of 75% of the total population.

Methods of analysis

Cronbach's alpha was used to measure the instrument's internal consistency and reliability by assessing the inter-item correlation, that is, determining how closely a set of items are related as a group. Cronbach's alpha is considered a measure of a scale's reliability (Stevens 2012). Therefore, the higher the value, the more reliable the measure. However, a "high" value does not mean a unidimensional measure. According to Schmitt (1996), if required, additional analyses could be performed to determine whether the measure is unidimensional, such as determining whether the inter-item correlation matrix fits a single-factor model. For this study, a measure of 0.7 was used to determine whether each construct's results were acceptable, as this value has been proven to return reliable results (George and Mallery 2011).

The Pearson product-moment or bivariate correlation expresses the strength of the relationship between two variables (George and Mallery 2011). Correlation values range from −1 to +1, where the magnitude of the value indicates the strength of the relationship and the direction (negative or positive) reflects the relationship's nature. A correlation coefficient of zero indicates no relationship between the variables at all. The assumption of using this method is that the two measured variables are approximately normally distributed (George and Mallery 2011). The Durbin-Watson statistic is used to test the remainder of the assumptions for sample suitability for parametric evaluation

and to ensure the residuals are independent (or uncorrelated). This statistic can vary from 0 to 4, with the optimal being 2. All values were within the range of 1 and 3, rendering the analysis valid (Stevens 2012). Cook's Distance statistic for each participant was determined. No value was over 1 to indicate significant outliers, which may place undue influence on the model. Scatter plots were also examined.

Numerous factors affect one dependent variable Y in multiple regression, as shown by the expression $Y = \beta0 + \beta1\times1 + \beta2\times2 + \beta3\times3 + \ldots ..+ \beta nxn$, where beta is the slope or weighted constant of the independent variables. If the linked variable has a higher score, the dependent variable will also rise. A negative score indicates a decline in the dependent variable. The notation R represents the strength of the relationship between the independent and dependent variables, while R^2 quantifies the percentage of variance in the dependent variable explained by the independent variables (George and Mallery 2011). The modified R^2 value only rises if the additional term improves the model.

Independent sample T-tests were used to compare the GRIT and SRL factors with gender. The null hypothesis is that the means for the groups are equal, versus the alternative hypothesis that the means were not equal (2-tail) or that the mean for one of the groups is larger than the mean for the other group (1-tail) was tested. The null hypothesis was rejected if $p \leq 0.05$. If $p > 0.05$, there is not enough evidence to conclude that the means are the same for the groups. Similarly, for a group containing more than two categories, one-way ANOVAs were used to compare GRIT and SRL factors with academic level (Year 1 vs Year 2 vs Year 3), age (≤18, 19-20, 21-22, 23-24, >24), and academic performance (High GPA ≥ 3.0, intermediate GPA 1.50-2.99, and low GPA ≤1.49).

Results and analysis

This section presents the scales' reliabilities, followed by descriptive statistics, bivariate correlations, and regression analysis.

Reliability of grit, motivational beliefs and SRL strategies scales

The internal consistency or reliability of the scales used in this study was analysed to determine whether the scales' performance on civil engineering students was acceptable. The results revealed that the Cronbach's alpha for the grit survey part-1, which includes consistency of interests, is 0.69 and grit survey part-2, which measured perseverance of effort, is 0.72; both results are acceptable and compare well with Duckworth et al. (2007) results. Regarding motivational beliefs, the Cronbach alpha values are acceptable, as reported values were 0.84 (self-efficacy), 0.75 (intrinsic value) and 0.80 (test anxiety). These values are comparable to those Pintrich and De Groot (1990) reported. Similarly, the reliability for cognitive strategy uses is 0.71, which is also deemed acceptable. However, low reliability for self-regulation of 0.48 was obtained.

Descriptive statistics

The descriptive statistics for grit, SRL and achievement variables are displayed in Table 1. The mean for the grit perseverance of effort variable appeared relatively high (Mean = 3.70) in comparison to the mean for consistency of interest (Mean = 3.12). Also, the means for the SRL variables were closer to the higher end of the scale.

Investigating grit and its relations with motivational beliefs and SRL strategies

Table 2 provides the correlations between the two constructs of grit, the five SRL dimensions, as well as the full grit, motivational beliefs and self-regulated learning strategies scales concerning current GPA. Contradictory to the study conducted by Wolters and Hussain (2015), consistency of interest

Table 1. Means and standard deviations for grit, self-regulated learning and achievement variables.

Variable	Mean	SD	N
Current GPA Range	3.00	1.140	101
Consistency of Interest	3.12	.727	101
Perseverance of Effort	3.69	.625	101
Grit	3.41	.433	101
Self-Efficacy	3.44	.603	99
Intrinsic Value	3.84	.512	100
Test Anxiety	3.31	.977	99
Cognitive Strategy Use	3.84	.447	98
Self-Regulation	3.42	.429	97
Motivational Beliefs	3.58	.407	97
Self-Regulated Learning Strategies	3.67	.402	96

was not significantly correlated with any of the other variables. However, perseverance of effort was positively correlated with intrinsic value, self-efficacy and the two types of self-regulatory strategies. Self-efficacy was positively correlated with intrinsic value and both self-regulated strategies. Intrinsic value was also positively correlated with both cognitive strategies use and self-regulation; whereas, test anxiety was low in correlation to the measures and negative with current GPA. Current GPA was positively correlated with perseverance of effort, self-efficacy and intrinsic value. These results indicate that motivational beliefs had a higher impact on students' GPA compared to grit. However, the tendency was weak despite a positive correlation between the variables since they were within the lower range ($0 < r < 0.5$).

The means were compared to confirm this finding, as seen in Table 3. Notably, the higher the GPA, the higher perseverance of effort (< 1.99 M = 3.38 and >3.60 M = 4.07) and grit score (<1.99 M = 3.24 and >3.60 M = 3.59). However, for the SRL motivational beliefs, the values are varying but in general they are increasing which as well suggests students with higher GPAs reported higher measurements of self-efficacy (< 1.99 M = 2.97 and >3.60 M = 3.68), intrinsic value (< 1.99 M = 3.64 and >3.60 M = 4.06) and motivational beliefs (< 1.99 M = 3.31 and >3.60 M = 3.70). This result shows that both grit and SRL contribute to GPA and, by extension, the student's academic failure or success.

Investigating gender, grit and SRL within civil engineering students

The grit and SRL variables were tested for association with gender to see if there were any correlations. Cognitive strategy use was the only positively correlated variable (0.247) with gender, while the other variables had no significant correlations at the $p \leq 0.05$ level. The means for each gender were compared on cognitive strategy use to understand the implications. The results show there is a difference in cognitive strategy use between males and females. Females displayed a higher mean score (3.99) as compared to males (3.76). Further, correlational assessment between grit, motivational beliefs and self-regulated learning strategies scales and gender revealed that self-regulated learning strategies positively correlated 0.206 with gender at the $p \leq 0.05$ level. Females (3.77) also possessed a higher mean score than males (3.60) on this scale. The other two scales showed no significance.

Investigating grit and SRL during the level of study

A Pearson bivariate correlation was undertaken between the level of study by year, grit, motivational beliefs, and self-regulated learning strategies scales. The results show that the study level has a significant negative correlation (-.263) with motivational beliefs. This negative direction of influence means that as one variable increases, the other variable decreases. A comparison of the means indicates that as the level of study increases, the mean motivational beliefs scores decrease (Year 1 = 3.76, Year 2 = 3.56, and Year 3 = 3.47). The correlation between the level of study and the individual

Table 2. Bivariate correlations between grit, SRL and students' current GPA range.

	Variables		1	2	3	4	5	6	7	8	9	10	11
1.	Current GPA Range	Pearson Correlation	1										
		Sig. (2-tailed)											
2.	Consistency of Interest	Pearson Correlation	.029	1									
		Sig. (2-tailed)	.777										
3.	Perseverance of Effort	Pearson Correlation	.325**	−.174	1								
		Sig. (2-tailed)	.001	.082									
4.	Self-Efficacy	Pearson Correlation	.372**	−.050	.476**	1							
		Sig. (2-tailed)	.000	.624	.000								
5.	Intrinsic Value	Pearson Correlation	.281**	−.102	.511**	.562**	1						
		Sig. (2-tailed)	.005	.314	.000	.000							
6.	Test Anxiety	Pearson Correlation	−.110	.156	−.106	−.229*	−.140	1					
		Sig. (2-tailed)	.278	.122	.296	.023	.171						
7.	Cognitive Strategy Use	Pearson Correlation	.181	.158	.495**	.396**	.467**	.085	1				
		Sig. (2-tailed)	.074	.121	.000	.000	.000	.413					
8.	Self-Regulation	Pearson Correlation	.089	.026	.387**	.308**	.343**	.177	.634**	1			
		Sig. (2-tailed)	.387	.804	.000	.002	.001	.086	.000				
9.	Grit	Pearson Correlation	.258**	.703**	.578**	.303**	.285**	.053	.487**	.301**	1		
		Sig. (2-tailed)	.009	.000	.000	.002	.004	.602	.000	.003			
10.	Motivational Beliefs	Pearson Correlation	.328**	−.018	.509**	.802**	.800**	.220*	.521**	.453**	.354**	1	
		Sig. (2-tailed)	.001	.862	.000	.000	.000	.030	.000	.000	.000		
11.	Self-Regulated Learning Strategies	Pearson Correlation	.157	.113	.494**	.395**	.460**	.139	.941**	.859**	.452**	.545**	1
		Sig. (2-tailed)	.126	.273	.000	.000	.000	.183	.000	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed); *. Correlation is significant at the 0.05 level (2-tailed).

Table 3. Means GPA for grit and SRL variables.

Current GPA Range		Perseverance of effort	Self-efficacy	Intrinsic value	Grit	Motivational Beliefs
<1.99	Mean	3.38	2.97	3.64	3.24	3.31
	Std. Deviation	.84268	.77564	.67762	.43944	.63397
2.00-2.49	Mean	3.49	3.37	3.59	3.25	3.44
	Std. Deviation	.61653	.47265	.46109	.57995	.33316
2.50-2.99	Mean	3.68	3.39	3.91	3.43	3.62
	Std. Deviation	.55963	.56686	.49241	.39112	.33844
3.00-3.59	Mean	3.89	3.74	3.96	3.50	3.72
	Std. Deviation	.57879	.49574	.47346	.36679	.36122
>3.60	Mean	4.07	3.68	4.06	3.59	3.70
	Std. Deviation	.34471	.51241	.28388	.34722	.26745
Total	Mean	3.69	3.44	3.84	3.41	3.58
	Std. Deviation	.62498	.60253	.51223	.43277	.40738

motivational belief measures was undertaken to determine which variable accounted for this change. Findings indicate that self-efficacy, a measure of motivational beliefs, has a negative correlation (-.250) with the year of study. Self-efficacy decreases as level of study by year increases (Year 1 = 3.71, Year 2 = 3.43, and Year 3 = 3.30). The other variables showed no significant correlation with the level of study. However, the mean grit (Year 1 = 3.44, Year 2 = 3.39, and Year 3 = 3.41) and self-regulated learning strategy (Year 1 = 3.67, Year 2 = 3.63, and Year 3 = 3.70) scores decreased from the year of entry to the second year and then increased in the final year.

Predicting self-regulated learning and academic achievement using multiple regressions

Predicting students' motivational beliefs

Aspects of grit, consistency of interest and perseverance of students' effort were examined in three separate multiple regressions which explored intrinsic value, self-efficacy and test anxiety. Current achievement, gender and age were included as control variables in the analysis. Tables 4 and 5 presents the results for the intrinsic value analysis. The analysis revealed that only perseverance of effort was determined to be the sole predictor of intrinsic value with a reported R^2 of 0.261 and adjusted R^2 of 0.254. In Table 5, the ANOVA significance of $p \leq 0.00$ suggests that the prediction model was significant at the 95% confidence interval. Using the following equation: $Y = \beta_0 + \beta_1 \times_1 + \beta_2 \times_2 + \beta_3 \times_3 + \beta_4 \times_4$ the significance of the influence (beta) can be expressed as 2.304 + 0.417 perseverance of effort for intrinsic value.

For self-efficacy, perseverance of effort and current GPA explained variance in this variable with reported values of R^2 (0.279) and adjusted R^2 (0.264). See Tables 6 and 7. Using the expression $Y = \beta_0 + \beta_1 \times_1 + \beta_2 \times_2$, self-efficacy can be expressed as 1.656 + 0.379 perseverance of effort + 0.129 current GPA range.

Evaluating both regression expressions reveals that intrinsic value is directly proportional to an individual's perseverance of effort, whereas self-efficacy is directly proportional to one's perseverance of effort and current GPA range. Consequently, these results suggest that students who indicated they sustained their engagement and continued to strive in achieving long-term goals also reported, on average, increased intrinsic value and greater confidence in themselves to successfully learn the material, with the latter also being supported by students' current GPA range. Similar to

Table 4. Intrinsic value model summary and ANOVA.

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
Perseverance of effort	.511	.261	.254	.443
Model	Sum of squares	df	Mean square	F
Regression	6.785	1	6.785	34.646
Residual	19.191	98	.196	Sig
Total	25.975	99		.000

Table 5. Regression coefficients for intrinsic value.

Model	Unstandardised β	Std. Error	Standardised β	t	*P*-value
(Constant)	2.304	.265		8.681	.000
Perseverance of effort	.417	.071	.511	5.886	.000

Wolters and Hussain's (2015) multiple regression study, the consistency of students' interest failed to emerge as a significant individual predictor for either aspect of motivational beliefs. Also, test anxiety did not have any significant predictors.

Predicting students' use of strategies and test anxiety

The two dimensions of grit, the three indicators of motivational beliefs in conjunction with the control variables, were used to predict the two self-regulated learning strategies and test anxiety. However, it must be noted that for test anxiety, the model was changed, where the test anxiety variable was excluded as an independent variable. The regressions were completed using a two-step process; the control variables and grit were modelled in the first step, followed by the three motivational variables in the second step. As presented in Table 8, the set of variables explained a significant amount of variance in cognitive strategy use, R^2 (0.364) and adjusted R (0.344). The ANOVA value $p \leq 0.00$ indicates the significance at the 95% confidence interval. Again, using the beta (influence) equation, $Y = \beta_0 + \beta_1 \times_1 + \beta_2 \times_2 + \beta_3 \times_3 + \beta_4 \times_4$, cognitive strategy use = 1.646 + 0.378 perseverance of effort + 0.158 consistency of interests + 0.224 intrinsic value. This finding implies that cognitive strategy use is directly proportional to the students' perseverance of effort, consistency in their interests, and intrinsic value. After adding the motivational belief variables to the model, as seen in Table 8, there was an increase in the amount of variance explained, R^2 (0.437) and adjusted R^2 (0.412). Hence, the difference (Δ) in R^2 and adjusted R^2 are 0.073 and 0.068, respectively. In terms of influence, the equation as seen from Table 9 is 0.980 + 0.267 perseverance of effort + 0.163 consistency of interest + 0.274 intrinsic value + 0.233 gender. Since these values are positive, it implies that cognitive strategy use is directly proportional to each of these variables.

As mentioned earlier, test anxiety failed to return any predictors when tested using the control variables age, gender and current GPA range. However, Table 10 shows a small amount of variance explained in the model generated using the other two motivational beliefs variables in step two, R^2 (0.054) and adjusted R^2 (0.044). The probability value of $p \leq 0.022$ for the ANOVA suggests significance at the 95% confidence interval. The beta (influence) equation obtained from Table 11 yields Y = 4.590 - 0.376 self-efficacy, which suggests that test anxiety is inversely proportional to self-efficacy. Therefore, the lower the student's self-efficacy, the higher their test anxiety. These findings indicated that students who reported that they were not confident in learning and understanding the material were also very anxious during or before exams.

Table 12 shows that only perseverance of effort explained a significant amount of self-regulation variance before adding the motivational belief variables as reflected in R^2 (0.387) and adjusted R^2 (0.149). After adding the motivational variables, the variance increased R^2 by 0.106 and adjusted

Table 6. Self efficacy model summary and ANOVA.

Model	R	R^2	Adjusted R^2	Std. error of the estimate
Perseverance of effort	.476	.227	.219	.533
Perseverance of effort, Current GPA Range	.528	.279	.264	.517
Model	Sum of squares	df	Mean square	F
Regression (1)	8.073	1	8.073	28.470
Residual	27.505	97	.284	Sig
Total	35.578	98		.000
Regression (2)	9.934	2	4.967	18.594
Residual	25.644	96	.267	Sig
Total	35.578	98		.000

Table 7. Self-efficacy regression coefficients.

Model	Unstandardised β	Std. Error	Standardised β	t	*P*-value
(Constant)	1.760	.319		5.513	.000
Perseverance of effort	.455	.085	.476	5.336	.000
(Constant)	1.656	.312		5.299	.000
Perseverance of effort	.379	.088	.397	4.335	.000
Current GPA Range	.129	.049	.242	2.639	.010

R^2 by 0.094 to values of 0.493 for R^2 and 0.243 for adjusted R^2. The ANOVA values $p \leq 0.00$ for both steps indicate the significance at the 95% confidence interval. The beta (influence) equation $Y = \beta_0 + \beta_1 \times_1$ for self-regulation is equal to = 2.448 + 0.263 perseverance of effort and for step-2, Y = 1.679 + 0.212 perseverance of effort + 0.120 test anxiety + 0.165 self-efficacy. These suggest that self-regulation is directly proportional to the students' perseverance of effort, test anxiety and self-efficacy. See Table 13.

Predicting students' current achievement

The control variables, two aspects of grit, the three indicators of motivation beliefs and two indicators of self-regulated learning strategies were used together to test possible predictors of students' current GPA range. The grit and control variables were used in the first step, followed by the other two sets of variables in the second. This model provided insight into whether the two dimensions of grit can account for the variance in civil engineering students' academic performance before and after considering their SRL.

The variables in the first step of the analysis explained a significant amount of variance with the following reported values of R^2 (0.179) and adjusted R^2 (0.162) for the perseverance of effort and, surprisingly, age variables. The beta equation for this model was 1.735 + 0.580 perseverance of effort – 0.281 age. This finding suggests that the current GPA range is directly proportional to a student's perseverance of effort but inversely proportional to their age. Therefore, students who reported that they sustained their engagement in achieving their goals also recorded a higher GPA. However, students with higher GPAs were younger. The addition of the SRL variables did not record an increase in variance R^2 (.179) and adjusted R^2 (0.162), where self-efficacy and age

Table 8. Cognitive strategy use model summary and ANOVA before and after adding motivational belief.

Model	R		R^2		Adjusted R^2		Std. Error of the Estimate	
Perseverance of effort (1)	.495	.499	.245	.249	.237	.241	.391	.395
Perseverance of effort, Consistency of interests (2)	.553	.558	.306	.311	.291	.296	.377	.380
Perseverance of effort, Consistency of interests, Intrinsic value (3)	.604	.613	.364	.375	.344	.355	.362	.364
Perseverance of effort, Consistency of interests, Intrinsic value, Gender (4)		.661		.437		.412		.347
Model (1)	Sum of squares		df		Mean square		F	
Regression (1)	4.751	4.797	1	1	4.751	4.797	31.111	30.772
Residual	14.660	14.497	96	93	.153	.156	Sig	
Total	19.411	19.294	97	94			.000	.000
Model (2)	Sum of squares		df		Mean square		F	
Regression (2)	5.930	6.002	2	2	2.965	3.001	20.895	20.772
Residual	13.481	13.292	95	92	.142	.144	Sig	
Total	19.411	19.294	97	94			.000	.000
Model (3)	Sum of squares		df		Mean square		F	
Regression (3)	7.071	7.240	3	3	2.357	2.413	17.953	18.218
Residual	12.340	12.054	94	91	.131	.132	Sig	
Total	19.411	19.294	97	94			.000	.000
Model (4)	Sum of squares		df		Mean square		F	
Regression (4)		8.429		4		2.107		17.455
Residual		10.865		90		.121	Sig	
Total		19.294		94				.000

Table 9. Regression coefficients for cognitive strategy use before and after motivational beliefs.

Model	Unstandardised β		Std. Error		Standardised β		t		*P*-value	
(Constant)	2.540	2.540	.236	.239			10.805	10.611	.000	.000
Perseverance of effort	.351	.353	.063	.064	.495	.499	5.578	5.526	.000	.000
(Constant)	1.952	1.937	.307	.312			6.367	6.220	.000	.000
Perseverance of effort	.381	.384	.061	.063	.538	.543	6.196	6.150	.000	.000
Consistency of Interests	.155	.157	.054	.055	.250	.253	2.883	2.864	.005	.005
(Constant)	1.646	1.327	.313	.360			5.266	3.683	.000	.000
Perseverance of effort	.378	.278	.059	.069	.534	.392	6.391	3.994	.000	.000
Consistency of Interests	.158	.160	.052	.052	.256	.260	3.062	3.071	.003	.003
Intrinsic value	.224	.259	.076	.085	.243	.295	2.984	3.031	.004	.003
(Constant)		.980		.362				2.682		.008
Perseverance of effort		.267		.066		.376		4.002		.000
Consistency of Interests		.163		.050		.266		3.288		.001
Intrinsic value		.274		.082		.315		3.382		.001
Gender		.233		.075		.250		3.135		.002

Table 10. Test anxiety model summary and ANOVA.

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
Self-efficacy	.233	.054	.044	.959
Model	Sum of squares	df	Mean square	F
Regression	5.003	1	5.003	5.435
Residual	87.452	95	.921	Sig
Total	92.455	98		.022

Table 11. Regression coefficients for test anxiety.

Model	Unstandardised β	Std. Error	Standardised β	t	*P*-value
(Constant)	4.590	.562		8.165	.000
Self-efficacy	−.376	.161	−.233	−2.331	.022

again were predictors of students' current achievement. Using the equation, $Y = \beta_0 + \beta_1 \times_1$, the beta (influence) = 1.482 + 0.619 self-efficacy - 0.213 age, which indicates the current GPA is also directly proportional to self-efficacy and inversely proportional to age. Moreover, this means that students who indicated that they were confident in their ability to learn the material also possessed higher GPAs and were in the younger age range. Similarly, Wolters and Hussain (2015), subsequent to adding the SRL variables, perseverance of effort was not a predictor of current achievement, as seen in Tables 14 and 15.

Table 12. Self-regulation model summary and ANOVA.

Model	R		R^2		Adjusted R^2		Std. Error of the Estimate	
Perseverance of effort	.387	.389	.149	.152	.140	.142	.398	.404
Perseverance of effort, Test Anxiety		.451		.203		.185		.394
Perseverance of effort, Test Anxiety, Self-efficacy		.493		.243		.218		.386
Model (1)	Sum of squares		df		Mean square		F	
Regression (1)	2.643	2.658	1	1	2.643	2.658	16.685	16.265
Residual	15.048	14.872	95	91	.158	.163	Sig	
Total	17.691	17.530	96	92			.000	.000
Model (2)	Sum of squares		df		Mean square		F	
Regression (2)	3.561		2		1.780		11.470	
Residual	13.969		90		.155		Sig	
Total	17.530		92				.000	
Model (3)	Sum of squares		df		Mean square		F	
Regression (3)	4.262		3		1.421		9.531	
Residual	13.267		89		.149		Sig	
Total	17.530		92				.000	

Table 13. Regression coefficients for self-regulation.

Model	Unstandardised β		Std. Error		Standardised β		t		*P*-value	
(Constant)	2.448	2.450	.241	.245			10.144	9.988	.000	.000
Perseverance of effort	.263	.264	.064	.066	.387	.389	4.085	4.033	.000	.000
(Constant)		2.049		.291				7.036		.000
Perseverance of effort		.283		.064		.417		4.402		.000
Test Anxiety		.100		.042		.229		2.411		.018
(Constant)		1.679		.332				5.054		.000
Perseverance of effort		.212		.071		.312		2.981		.004
Test Anxiety		.120		.042		.274		2.876		.005
Self-efficacy		.165		.076		.233		2.170		.033

Discussion

Duckworth, Quinn, and Seligman (2009) suggested that grit is a stable attribute that could predict or explain students' academic outcomes. Arguably, this indicates that grittier students are expected to persevere more when faced with adversity and continue to pursue challenging long-term goals, such as completing a civil engineering degree over three years. This research provides further evidence that civil engineering students' engagement in self-regulated learning can offer a platform to understand how grit mediates academic success. Additionally, the findings also support the need to comprehend the differences between the two aspects of grit. This section elaborates on the evidence for these contributions, discusses the implications for educational practice, and makes recommendations based on this research's limitations.

The theoretical link between grit and civil engineering students' SRL

There is no prior empirical study linking grit and SRL in civil engineering students. This study's findings address this gap by relating grit traits to SRL indicators of civil engineering students. The evidence suggests that perseverance of effort is a predictor for two dimensions of motivational

Table 14. Current GPA range model summary and ANOVA.

Model	R		R2		Adjusted R^2		Std. Error of the Estimate	
Perseverance of effort	.325	–	.106		.097	.	1.084	
Perseverance of effort, Age	.423	–	**.179**		**.162**	.	1.044	
+ Motivational & SRL strategies								
Model	Sum of squares		df		Mean square		F	
Self-efficacy	–	.370		.137		.128		1.062
Self-efficacy, Age	–	.423		**.179**		**.162**		1.041
Model	Sum of squares		df		Mean square		F	
Regression (1)	13.740		1		13.740		11.701	
Residual	116.260		99		1.174		Sig	
Total	130.000		100				.000	
Model	Sum of squares		df		Mean square		F	
Regression (2)	23.284		2		11.642		10.691	
Residual	106.716		98		1.089		Sig	
Total	130.000		100				.000	
+ Motivational & SRL strategies								
Model	Sum of squares		df		Mean square		F	
Regression (1)	16.139		1		16.139		14.314	
Residual	101.470		90		1.127		Sig	
Total	117.609		91				.000	
Model	Sum of squares		df		Mean square		F	
Regression (2)	21.093		2		10.546		9.725	
Residual	96.516		89		1.084		Sig	
Total	117.609		91				.000	

Table 15. Regression coefficients for current GPA range.

Model	Unstandardised β	Std. Error	Standardised β	t	*P*-value
(Constant)	.809	.650		1.245	.216
Perseverance of effort	.593	.173	.325	3.421	.001
(Constant)	1.735	.700		2.481	.015
Perseverance of effort	.580	.167	.318	3.472	.001
Age	−.281	.095	−.271	−2.960	.004
(Constant)	.598	.628		.953	.343
Self-efficacy	.681	.180	.370	3.783	.000
(Constant)	1.482	.741		1.998	.049
Self-efficacy	.619	.179	.337	3.462	.001
Age	−.213	.100	−.208	−2.137	.035

beliefs associated with SRL (intrinsic value and self-efficacy). This finding indicates that more conscientious students worked harder and were less demoralised by setbacks, had a higher value and interest for the degree, and possessed greater confidence in their ability to complete the tasks assigned. Also, the consistency of interest that represents students' sustained interest in pursuing their goals returned no correlation to either aspect of SRL.

This research also found that grit's two dimensions may describe two strategies common to SRL among civil engineering students. Considering intrinsic value and self-efficacy, students who reported to be more diligent and worked harder possessed increased cognitive strategy use and self-regulation than those who did not. This study's findings support the prospect of grit, another individual trait-like difference that can also be used to describe the principal aspects of SRL among a diverse group of civil engineering students.

Are grit and SRL contributing factors to students' GPA?

Both grit and SRL contributed to a student's current GPA and, by extension, academic success or failure. Perseverance of effort was positively correlated with student GPA, which suggests that students with higher GPAs compared to those with lower GPAs tended to be more diligent, less discouraged by setbacks, and worked harder. Grit also was positively correlated with GPA, which indicates that grittier students earn a higher GPA. This result suggests that students who are more focused and not deterred by setbacks will perform better, a finding also supported by Duckworth, Quinn, and Seligman (2009) and Wolters and Hussain (2015). Similar to Wolters and Hussain (2015) findings, consistency of interest did not correlate with students' current GPA.

Therefore, whether students maintained a sustained effort not relating to their subjective interest but instead associated with a fear of change, submitting to others' expectations or unawareness of alternative options, such effort does not impact their GPA. As it relates to SRL, self-efficacy, intrinsic value, and motivational beliefs positively correlate with GPA. Therefore, students with higher GPAs also recorded higher self-efficacy qualities, which means they had greater confidence in their ability to complete coursework and attain the degree. Students with higher GPAs are in good academic standing, and their performance goals have already been met, and their perceived level of competence and resulting self-efficacy may be higher (Pintrich 2003). These findings are the same as presented by Martín and Sorhaindo (2019) and Martin et al. (2018), who explored civil engineering students' motivation. Students possessing higher intrinsic value and motivational beliefs also performed better in terms of GPA. This finding implies that students who were motivated to learn rather than focusing on only obtaining good grades and believed that their work in the degree was interesting and important, preferred challenges with the intent of developing mastery, and perceived classes taught in the degree to be of importance, got higher grades. A study conducted by Alias, Akasah, and Kesot (2016) found that civil engineering students were more intrinsically motivated. Therefore, these findings indicate that grit and SRL are linked to academic success or failure in the degree, as students who possess low scores in these traits also attain lower GPA scores.

Are there gender differences in grit and SRL?

There were no significant differences between males and females concerning grit, thereby supporting studies conducted by Duckworth et al. (2007) and Duckworth, Quinn, and Seligman (2009). Like the aforementioned studies, the distribution of males to females was skewed (males = 64, females = 37), which could be a reason for the observed result. However, the effects of this limitation in this study are unavoidable as civil engineering is a male-dominated profession. The current study also found a correlation between gender and cognitive strategy use as well as self-regulated learning strategies. Further analysis indicated that females had higher measures in both variables. Therefore, it can be deduced that females use more cognitive strategies and use more self-regulated strategies than their male classmates. The research compares the means for each of the seven grit and SRL scales to understand gender differences. The findings revealed that females recorded higher means in four of the seven measures and the remaining three were male-dominated. Females were higher in perseverance of effort, test anxiety, cognitive strategy use and self-regulation, whereas males showed higher means in the consistency of interest, self-efficacy and intrinsic value variables. Males possess higher motivational beliefs compared to females. This difference can be attributed to engineering being traditionally a male-dominated field. Also, males were more confident in their performance throughout the degree, preferred challenges and had a greater appreciation for the classes taught. The results also indicated that males had a higher consistency of interest representing their belief that they maintained in pursuit of their goals.

On the other hand, females recorded higher scores in one aspect of grit, both self-regulated learning strategies and test anxiety. Although not significantly different, females reported being more diligent, working harder, and being less discouraged by setbacks in attaining their goals. Females' level of diligence can close the gender disparity in engineering, as described by Pawley (2019). Moreover, the results supported the study by Martin, Sorhaindo, and Welch (2014), where females displayed better cognitive strategy practices such as summarising and organisation and self-regulation, which included metacognitive strategies such as planning and comprehension monitoring. Finally, females recorded a slightly higher test anxiety measure than males; however, this did not support Pintrich and De Groot (1990), where highly anxious students displayed less self-regulation than those who were not anxious. This interpretation implies that females have better self-regulatory practices than males; however, they tend to be more nervous before and during exams.

Is there a difference in grit and SRL between years of study?

Using Pearson's correlation coefficient, the results indicated a significant difference in self-efficacy between the year levels. Self-efficacy represented students' confidence in their ability to complete the coursework and assigned tasks. The findings show that students' self-confidence decreases at higher levels of study. This decrease could be due to the increase in courses, coursework, department culture and difficulty of the previously mentioned factors. A simple means comparison was conducted, and findings showed that motivational beliefs decreased likewise. This finding supports the study carried out by Martin, Sorhaindo, and Welch (2014), which also revealed the motivation decreased at higher levels of study. However, the analysis found a decrease in grit and self-regulated learning strategies between Year 1 and Year 2 and an increase between Year 2 and Year 3. These results could suggest that students may lose their interest or passion for attaining the degree in the transition from Year 1 to Year 2, as well as not make use of planning strategies but regain those attributes upon entering Year 3. This study recommends a longitudinal evaluation of these differences.

Implications for educational practice

Throughout this study, grit and SRL are seen to have an impact on students' academic achievement. The study revealed that grit and SRL contribute to student GPA and their academic failure

or success by extension. Perseverance of effort was a positive predictor of students' SRL engagement and academic performance. However, according to Wolters and Hussain (2015), this aspect of grit may not be easily modified. As Duckworth et al. (2007) explain, grit's conceptual understanding has a broader scope, particularly perseverance of effort, which has stable trait-like inherited qualities from genetics or developed over time. Nonetheless, learning to stick to a task is a developable skill that often originates from the fascination with that task or a greater purpose of improving society. Influencing students by advising on the refinement of their developed study habits and methods is the most likely area for improvement. In this way, a growth mindset is fostered in which long term success is dependent on a core belief beyond perceived individual ability.

Few studies (Alias, Akasah, and Kesot 2016) investigate SRL components among civil engineering students within universities. Studies have suggested that increased self-regulation strategies and modifying motivational beliefs based on a situation can be achieved by implementing a well-structured framework (Schunk and Zimmerman 2008). Therefore, it would be more beneficial if lecturers paid attention to the motivational and strategic components of SRL. Techniques such as designing course assessments with supplementary parts would cater to students who possess low SRL measures and encourage them to engage in multiple learning strategies throughout assessments. The link between perseverance of effort and students' SRL can provide useful improvement measures. It is known that students pursue a degree or enter university for various reasons such as the passion for the degree, the income associated with the degree, the level of difficulty of the degree or sometimes family expectations. Hence, it may be important that lecturers promote the benefits of learning, academic achievement and graduation as personal goals and not entirely based on external influences in some cases. Subsequently, students will then have an appreciation for their long-term personal goals, and as a result, some students may attain the grit trait-like characteristics and therefore work more diligently and harder to achieve one's personal goals.

The results also indicate that females used cognitive and self-regulated learning strategies better despite males having higher motivational beliefs throughout the three years of study. Given that self-regulated learning (SRL) is an essential predictor of student academic achievement and motivation, this would entail students strategising better in terms of planning, goalsetting, motivating themselves, and modifying their cognition (Zimmerman 2011). Realistically, very few students do this naturally well and, therefore, they need assistance with triggering these traits. Similarly, course assessments that engage multiple learning strategies could be administered, allowing students to adjust said strategies. Contrary to previous studies by Martin, Sorhaindo, and Welch (2014), females need to be motivated more in their intrinsic value, which is positively correlated with four out of the seven individual variables measured. In line with Pintrich and De Groot (1990), intrinsic value correlated with cognitive strategies and self-regulation and was a predictor for cognitive strategies; however, it was not a predictor of GPA. This finding means that students who were motivated to learn the material and believed that coursework was important were more cognitively engaged in comprehending and learning the course's material. Therefore, the results imply that lecturers should associate students' intrinsic value to coursework (Corno and Rohrkemper 1985) to engage more cognitive strategy uses.

Finally, the results indicated that each year group differed for motivational beliefs. Concerning motivation, self-efficacy was the only significant positively correlated variable with the year level of study. These findings suggest that lecturers should implement strategies to assist students in their confidence towards completing the degree. The lack of confidence and, by extension, motivation may result from increasing workload throughout the years, in particular Year 3 (final year). Actioned plans in bridging the workload gap included the department reducing the number of artefacts in the final year of study in the medium term and through guidance counselling in the short term.

Conclusion

This work investigates whether grit and SRL together can be used to understand civil engineering students' academic achievement, whether grit can be used as a predictive indicator of students' engagement in SRL, and the evaluation of the variability of grit and SRL according to the undergraduate year of study, and gender. The findings indicate a relationship between Grit and SRL's constructs and their connection to civil engineering students' academic achievements. Results revealed that one construct of grit, perseverance of effort was a predictor for four of the five SRL indicators, including intrinsic value, self-efficacy, cognitive strategy use and self-regulation. Initially, perseverance of effort predicts the current GPA; however, it was no longer a predictor after considering the SRL indicators. This difference suggests that students' SRL engagement possibly mediates the relation between academic achievement and grit. The second construct of grit, consistency of interest, was only a predictor for cognitive strategy use and did not influence the current GPA. The study also shows that self-efficacy and age were positive and negative predictors of students' GPA, respectively. An indication that students' perceived competence and confidence in themselves to complete the degree was an important factor towards their GPA, whereas the younger the students were, the higher their GPA compared to their older classmates. Furthermore, findings indicated that motivational beliefs had a higher impact on students' GPA compared to grit. Females were higher in most of the constructs measured in the study.

Small populations limit the sample size to 101 students compared to Burkhart et al. (2014), and Duckworth et al. (2007) studies investigating grit. However, more than 50% of all studies on GRIT are limited by sample sizes below 200 participants because of the cohort size (Direito, Chance, and Malik 2021); our study is not exempted from such limitations. The sample size being predominantly males skewed the analysed data. Since, traditionally, engineering is a male-dominated field, reducing this limitation towards achieving a more gender-balanced study may be impractical at this time. Few studies have explored differences between academic vocations and grit, but likely differences between vocations and other personal traits, such as motivation, might also exist with grit. Further exploration should be carried out. Adjustments for cultural differences in the original instrument, as suggested by Lee et al. (2002), limits interpretations. There is presently no evidence on the influence of specific academic and non-academic policies or programmes in schools on the development of grit in educational settings, but it is also necessary to understand the possible negative implications of grit on well-being outcomes. Further studies are needed to resolve these shortcomings considering that an individual's interest and behaviour are context-dependent, necessitating further longitudinal research, especially exploring the interaction influence of Grit with peers.

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Appendix A: Grit and MSLQ Survey Items.

Grit

Consistency of Interests

1. I often set a goal but later choose to pursue a different one.
2. New ideas and new projects sometimes distract me from previous ones.
3. I become interested in new pursuits every few months.
4. My interests change from year to year.
5. I have been obsessed with a certain idea or project for a short time but later lost interest.
6. I have difficulty maintaining my focus on projects that take more than a few months to complete.

Perseverance of Effort

7. I have achieved a goal that took years of work.
8. I have overcome setbacks to conquer an important challenge.
9. Setbacks don't discourage me.
10. I finish whatever I begin.
11. I am a hard worker.
12. I am diligent.

Motivational Beliefs

Self-Efficacy

2. Compared with other students in this degree I expect to do well.
6. I'm certain I can understand the ideas taught in this degree.
8. I expect to do very well in this degree.
9. Compared with other students in this degree, I think I'm a good student.
11. I am sure I can do an excellent job on the problems and tasks assigned in this degree.
13. I think I will receive good grades in this degree.
16. My study skills are excellent compared with others in this degree.
18. Compared with other students in this degree, I think I know a lot about the degree.
19. I know that I will be able to learn the material for this degree.

Intrinsic Value

1. I prefer course work that is challenging so I can learn new things.
4. It is important for me to learn what is being taught in class.
5. I like what I am learning in this degree.
7. I think I will be able to use what I learn in this degree in other fields.
10. I often choose topics I will learn something from even if they require more work.
14. Even when I do poorly on an exam I try to learn from my mistakes.
15. I think that what I am learning in this degree is useful for me to know.
17. I think that what we are learning in this degree is interesting.
21. Understanding of courses is important to me.

Test Anxiety

3. I am so nervous during an exam that I cannot remember facts I have learned.
12. I have an uneasy, upset feeling when I take a test.
20. I worry a lot about exams.
22. When I take an exam, I think about how poorly I am doing.

Self-Regulated Learning Strategies

Cognitive Strategy Use

23. When I study for a test, I try to put together the information from class and from the book.
24. When I do homework, I try to remember what the lecturer said in class, so I can answer the questions correctly.
26. It is hard for me to decide what the main ideas are in what I read.
28. When I study I put important ideas in my own words.
29. I always try to understand what the lecturer is saying even if it doesn't make sense.
30. When I study for an exam I try to remember as many facts as I can.
31. When studying, I copy my notes over to help me remember material.
34. When I study for an exam I practice saying the important facts over and over to myself.
36. I use what I have learned from previous assignments and the textbook to do new assignments.
39. When I am studying a topic, I try to make everything fit together.
41. When I read material for a course, I say the words over and over to myself to help me remember.
42. I outline chapters to help me study.
44. When reading I try to connect the things I am reading about with what I already know.

Self-Regulation

25. I ask myself questions to make sure I know the material I have been studying.
27. When work is hard I either give up or study only the east parts.
32. I work on practice exercises and answer end of chapter questions even when I don't have to.
33. Even when study materials are dull and uninteresting. I keep working until I finish.
35. Before I begin studying I think about the things I will need to do to learn.
37. I often find that I have been reading for a course but don't know what it is all about.
38. I find that when the lecturer is talking, I think of other things and don't really listen to what is being said.
40. When I'm reading I stop once in a while and go over what I have read.
43. I work hard to get a good read even when I don't like a course.