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Non-cognitive predictors of academic success: a self-determination and mental toughness perspective

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Non-cognitive predictors of academic success: a self-determination and mental toughness perspective

ABSTRACT

Associates and predictors of academic success have dominated educational enquiry, often investigating final grade outcomes. The current study aimed to investigate the prediction of grades and academic self-concept (ASC) using non-cognitive variables often associated with university performance. 135 participants completed questionnaires for Mental Toughness (MT), Self-Determination (SD) and ASC alongside providing year one and two grades of undergraduate study. A 1x3 independent ANOVA was used to investigate developments of ASC, MT and SD across the degree, with multiple regression analyses used to predict grades and ASC. T-tests were used to investigate grade differences, alongside gender differences in all variables. While some MT and SD aspects did predict outcomes, ASC was unexpectedly influential when predicting grades. ASC increased significantly across the degree period, while grades, MT, and SDT did not. No MT or SD advantage or gender differences were found. Recommendation for further research into ASC prediction of grade outcome was made.

KEY WORDS:	MENTAL TOUGHNESS	SELF-DETERMINATION	ACADEMIC SUCCESS	ACADEMIC SELF-CONCEPT	UNDERGRADUATE

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Introduction

Academic success (synonymous with performance, attainment and achievement) is often associated with educational psychology due to interests in revealing associates and predictors of success (Ruffing et al., 2015). A clear definition is difficult to obtain (York et al., 2015), most using the previously outlined terms interchangeably to discuss intellectual outcomes regarding grades and cognitive ability (O'Hare and McGuinness, 2015). However, requests for more dynamic definitions are frequently made (Green et al., 2012) and while many concepts have been proposed, recent progression of academic self-concept (ASC) has been increasingly well received; ASC is a positive psychology term used to describe '…an evaluative self-perception that is formed through the student's experience…' (Guay et al., 2010:644). Although historically criticised for poor quality concepts and measurements (Marsh and Martin, 2011) alongside questioning of ASC and achievement relationships due to difficulty interpreting direction of effect (Guay et al., 2010), ASC is now considered a key force behind intellectual outcomes (Marsh and Martin, 2011) with improvements in both measures across the degree often defined (Baumeister et al., 2013). Initial decreases in grades are repeatedly observed across years one to two of undergraduate study (Grove and Wasserman, 2004), however a general improvement across the degree is more-often reported (Brändle and Lengfeld, 2017). A significant female advantage in grade outcome is also suggested (Ismail and Othman, 2006; Sheard, 2009), additionally shown when addressing gender imbalance of ASC (Khwaileh and Zaza, 2011). ASC has been suggested to improve across the degree period in a reciprocal relationship with achievement (Baumeister et al., 2013), and so the current paper defines academic success as a combination of intellectual outcomes and self-concept projections to investigate academic success as a generalised concept.

General intellect is often considered the most powerful predictor of academic performance (Spinath et al., 2006), however recent evaluations have indicated an inability for this concept to explain the entire predictability of success when regarding post-secondary education (Conard, 2006; Kappe and van der Flier, 2010). Due to entry requirements, students are studying at comparable cognitive levels (Boekarts, 1995) and so predictability becomes less accurate due to less variation in cognitive aptitude (Ruffing et al., 2015). Kornilov et al. (2009) additionally revealed between 0.29 and 0.40 predictability variance of the intelligence factor alone, reflecting the need for further investigation into other concepts to elucidate the remaining variance in success (Richardson et al., 2012). Academics are now increasingly interested in non-cognitive determinants of performance (Ruffing et al., 2015) due to abilities to predict more accurately at post-secondary levels (Lin et al., 2017) and opportunities to provide interventions due to flexible personality conceptualisations (McGeown et al., 2016).

Mental Toughness

With origination through sports psychology (McGeown et al., 2017) and hardiness enquiries (Clough et al., 2002), MT is a non-cognitive attribute defined as a personality construct which '...allows one to remain relatively unaffected by stressors and to strive in challenging situations.' (Lin et al., 2017:178). MT has recently indicated great presence within educational enquiry (St Clair-Thompson et

al., 2014), a positive relationship between age and MT demonstrating the ability for this concept to improve over time (Marchant et al., 2009) and for MT focused intervention within the student population (Lin et al., 2017). While some propose a unidimensional construct (Gucciardi et al., 2015), most agree to a multidimensional definition of MT consisting of multiple components (Crust, 2008).

Providing the most accepted and referenced model of MT (Crust et al., 2014), Clough et al. (2002) conceptualise MT with four distinct factors: (1) control (emotional and life); measures the ability to feel in control of our own lives, (2) commitment; defines the ability to continue throughout pressures to achieve goals, (3) challenge; reflecting the extent to which we view setbacks as opportunities for growth, and (4) confidence (in abilities and interpersonal); reflecting belief in one's ability. Clough et al. (2002) additionally published a measurement tool; the Mental Toughness Questionnaire (MTQ-48) is a 48-item questionnaire measuring each factor independently and collectively (Crust et al., 2014), and while initially criticised due to factor structure (Gucciardi et al., 2012) has since been found to have good reliability (Dewurst et al., 2012) alongside robust factor, psychometric, criterion and construct validity (Crust and Clough, 2005; Perry et al., 2013).

Using this model, St Clair-Thompson et al. (2014) studied MT influences on secondary school academic performance. St Clair-Thompson et al. (2014) found positive associations between MT, challenge, commitment, control and control of life, MT accounting for 12% of variance within academic attainment. However, subcomponents control of life, emotional control and interpersonal confidence produced unsatisfactory Cronbach's alpha levels (.47, .50 and .51 respectively), the emotional control scale regularly considered unsatisfactory within investigations (Perry et al., 2013). However, sampling age was implicated in the production of such poor reliability, comparisons to reliability assessments of older participants evidencing the subscales reliable worth (Crust and Swann, 2011). While questioning the extent to which the MTQ-48 can be applied to younger populations, findings demonstrate the usefulness of the non-cognitive attribute within general academia and its positioning within the current research is made clear.

Comparatively, Crust et al. (2014) investigated MT influences in post-secondary academia, studying outcomes of undergraduate sports students. Academic performance was significantly better for those reporting higher MT, again indicating the relevance of MT within academia (Crust et al., 2014). While this publication reviewed sporting domains, often criticised due to heavy domination of MT within this field (Gerber et al., 2012), the paper enabled investigation of such concepts within previously unexplored higher education, demonstrating clear implications of MT within this group (Crust et al., 2014). Alongside this, Crust et al. (2014) found men consistently reported higher levels of MT than women, reflecting previous findings within literature (Nicolls et al., 2009) and further specifying MT applications. However, previously outlined complications regarding unsatisfactory reliability are recurrent; Crust et al. (2014) failed to reveal reliability scorings for control and confidence, only publishing general scale reliabilities. However, although clearly requiring further consistency investigations this study again implicates the presence of MT within post-secondary enquiries.

More recently, Lin et al. (2017) investigated psychology undergraduate students' MT and academic associations. While general positive associations with grades were made, confirming the proposed relevance within tertiary-education longitudinally, it also found MT to predict approximately 9% of variance of academic

outcomes. Alongside this, scales control and commitment greater predicted academic performance (16.5%) therefore defined as stronger predictors of academic outcomes (Lin et al., 2017). While this indicates the specified relationship of MT to higher education, another failure to disclaim subscale reliabilities suggest readers are again advised to approach results with caution.

Self-Determination Theory

When discussing relations with other non-cognitive concepts, Gucciardi and Mallett (2010) and Mallett and Coulter (2011) both indicated association of MT with self-determination (SD) concepts, followed by a detailed comparison produced by Mahoney et al. (2014a). Mahoney et al. (2014a) suggest both MT and SD to be fostered by comparable environments, proposing MT is enhanced by the '…energizing effects of psychological needs satisfaction.' (Mahoney et al., 2016:201).

Self-Determination Theory (SDT) (Deci and Ryan, 1985; Deci and Ryan, 2000) encapsulates how individual's decisions are freely assumed and explain the drive behind our actions (Deci and Ryan, 2008). SDT for the first time introduced a multidimensional model in which the specific type of motivation displayed overruled any form of general quantity contrary to traditional conceptualisations (Deci and Ryan, 2008), developments now extending the ideologies across educational contexts (Ryan and Deci, 2000) which can be developed over time (Deci and Ryan, 2002).

Basic Psychological Needs Theory (BPNT; Ryan and Deci, 2002), a mini theory of the broader model, is based around three psychological needs fuelled by internal motivation: (1) autonomy; the idea all actions are due to personal volition (Mahoney et al., 2014b), (2) competence; the satisfaction in personal abilities and capability (Sun et al., 2017) and (3) relatedness; a sense of belonging within a community (Trenshaw et al., 2016). A measurement to quantify need satisfaction was also created; The Basic Psychological Needs Scale (BPNS) (Deci and Ryan, 2000; Gagné, 2003) is a 21-item questionnaire measuring each factor's satisfaction independently and generally. While many scales have been developed for the measurement of SD (Molix and Nichols, 2013; Chen et al., 2015), the BPNS was created specifically for use alongside the theoretical conception (Deci and Ryan, 2000), boasting cultural generalisability, satisfactory reliability and significant positive correlations across the three needs (Ciyin and Erturan-Ilker, 2014).

The needs defined above are inherently fuelled by intrinsic motivation; intrinsic motivation regards the internal desire to engage in behaviours for pleasure regardless of external reward (Deci et al., 1991), and is often regarded crucial for academic motivation and success (Deci and Ryan, 2000). When investigating achievement of basic psychological needs, Ng et al. (2016) found intrinsic motivation to associate highly with better academic outcomes within school-age participants, evidencing theoretical presence within academic domains. However, while SDT has been suggested to be cross-culturally applicable (Deci and Ryan, 2008), methodological scrutiny revealed differing schooling practises deviating from those in the UK and therefore true applicability to children outside of Singapore is questioned. Nonetheless, in a meta-analysis Taylor et al. (2014) found intrinsic motivation to be the strongest predictor of academic success within the schooling population when

using an extended cultural sample, corroborating the relevance of SDT principles in predictability of academic outcomes globally.

Furthermore, Vecchione et al. (2014) found intrinsic motivation conceptualised within SDT to significantly predict grade outcomes of elementary school, high school and university students (.13, .39 and .37 respectively). These results demonstrate the longevity of SDT principles to predict across educational levels and its presence within tertiary investigations is further evidenced. Moreover, predictive power of intrinsic motivation was stronger for females and in some cases non-significant regarding the male cohort, indicating gendered effects of the motivational style (Vecchione et al., 2014). Alongside this, qualitative investigations by Naude et al. (2016) revealed strong rooting of SD principles within academic outcomes and internal evaluations, evidencing SDT's stance within both attainment and ASC. However, both aforementioned investigations used psychology students within their sample and while enlightening the heavily sports-dominated concept (Sun et al., 2017) reduced applicability is therefore demonstrated.

This being said, many academics additionally recommend autonomy-supportive environments to more dominantly foster academic improvements (Ryzin et al., 2009). O'Reilly (2014) explored undergraduate performance within an autonomy-supportive setting, finding autonomy to account for 9% of academic outcomes. While findings echoed previous literature reflecting an autonomy preference (Deci and Ryan, 1985; Noels et al., 2001), Bronson (2016) was unable to reflect significant findings when exploring nursing students' academic outcomes within an autonomy-supportive environment. However, Bronson (2016) did still advocate enhancements of autonomy-supportive strategies, demonstrating the presence of such concepts on academic enhancement regardless of statistical insignificance.

Considering the above, both MT and SDT concepts clearly belong within the predictability of academic outcomes, both perhaps able to provide further understandings of higher educational attainment. With both concepts heavily reliant on sporting samples (Gerber et al., 2012; Sun et al., 2017), few focused considerations within a UK higher education cohort and lack of comparison of MT and SDT predictability, the current research plans to investigate comparable predictability of the concepts on academic success, possible improvement of grades and ASC, and SDT and MT projections across the degree. While general aims of the current research also aim to investigate generalised gender differences, the following hypotheses will additionally be tested:

1) *MT and SD will predict academic success and ASC*
2) *ASC will increase across the degree period*
3) *MT and SD will increase over the degree period*

Methods

Design

A cross-sectional correlational design was used, an 80-item online questionnaire gathering MT, SD, ASC and grade information alongside demographic

data. The study measured predictor variables MT and SD on criterion variables ASC and academic grades (additionally ASC on grade outcome) within multiple regression analyses, alongside independent variable university year-group investigating changes in dependent variables ASC, MT and SDT in a 1x3 ANOVA. T-tests assessed gender comparisons and grade differences.

Participants

137 undergraduates participated in the study (47, 33 and 57 students from years one, two and three respectively), acquired primarily by opportunity sampling on a university participation system. Additional participants were acquired through online university forums. Participants identified as male (37), female (94) and non-binary (5), with one preferring not to say. Two responses were removed for incomplete data, leaving 46, 32 and 57 participants from years one, two and three respectively. Participants were asked not to participate if studying outside the UK or completing a degree regarding sport.

Materials

Two previously validated psychometric questionnaires were used – the Mental Toughness Questionnaire (MTQ-48) (Clough et al., 2002) (access confirmed internally through university contacts) (Appendix 1.) to measure MT and the Basic Psychological Needs Scale (BPNS) (Deci & Ryan, 2000; Gagné, 2003) (Appendix 2.), free to access online.

The MTQ-48 includes 48 questions, asking participants to rate how much each statement describes them. A sample item is: "I generally feel in control" with all questions summarised by a score for each individual domain alongside general MT. The MTQ-48 has continually found satisfactory reliability generally (0.93) and for all subscales (above 0.7) (Dewurst et al., 2012), alongside psychometric and factor validity using confirmatory factorial analyses and exploratory structural equation modelling (Perry et al., 2013). Good criterion and construct validity have also been demonstrated by correlations with life satisfaction (.56) and trait-anxiety (.57) (Crust and Clough, 2005).

The BPNS includes 21 questions asking participants how much each statement describes them. A sample item is: "I feel pressured in my life", with all questions summarised for each domain and a general score. Subscales autonomy, competence and relatedness boast Cronbach's alpha levels of 0.79, 0.78, 0.76 respectively, alongside significant positive correlations between each need (.607, .618, .445) (Ciyin and Erturan-Ilker, 2014).

Both measures were combined with final year grade from previous academic year (years one and/or two where applicable) and 7 simple Likert style questions to measure ASC (Appendix 3.). ASC measurement was influenced by previously validated self-concept questionnaires (Reynolds, 1998; Liu et al., 2005) which due to limited access alongside cross-cultural applicability concerns was not used. A sample item is: "I am satisfied with my academic progress".

Procedure and ethics

Participants were invited to complete the anonymous questionnaire by Manchester Metropolitan University's participation pool system, designed for participant acquisition after acceptance of study proposal by the ethics board (Appendix 4.). Invitations (Appendix 5.) were additionally placed on online university forums. Participants were presented with an information sheet (Appendix 6.) outlining study details, then asked to proceed with consent if agreeing to all terms (Appendix 7.).

Participants were asked questions concerning identifying gender and study year, followed by all aforementioned questions dependent on year of study selected. Once complete, participants were presented with a debrief (Appendix 8.) outlining study plans alongside guidance for support. Participants provided an anonymous personal code able to be extracted if necessary, up until the 01/03/2018.

Analysis outline

Totals for all scales and subscales were created and necessary questions reverse scored. A principle components analysis was conducted to assess ASC scale suitability. Preliminary parametric assumptions were then established, ascertaining data as interval while assuming a normally distributed dataset (using histograms, Kolmogorov-Smirnov, Shapiro-Wilk and QQ-plots). Descriptive statistics and reliability analyses (Cronbach's alpha) were displayed.

Assumptions ensuring bivariate relationships between variables ASC, MT and SDT were carried out, followed by Pearson's bivariate correlations to asses relationships between all scales and subscales and academic grades.

A 1x3 independent one-way ANOVA was conducted to investigate differences across degree period regarding ASC, MT and SDT. Homogeneity of variance was assumed using the Levene statistic. A Tukey test assessed the nature of significant differences found for ASC, followed by a repeated measures t-test to assess grade differences.

Variables indicated by correlations and suggested within literature to strongly predict academic success were placed in multiple regression analyses. Any non-significant findings which disproportionately influenced outcome were removed and the test ran again.

Finally, independent t-tests were conducted to asses gender differences in all variables.

Analysis

Data was exported from Qualtrics into SPSS (Appendix 9. for SPSS output). Due to the use of Likert type questions and summed responses, data was regarded at least interval as per Carifio and Perla (2007) suggestions. Histograms appeared to represent normality (Appendix 10.), however further tests (Kolmogorov-Smirnov and Shapiro-Wilk) revealed unwanted statistically significant results of ASC, MT, relatedness (SDT), emotional control (MT), control (MT), confidence in abilities (MT), and interpersonal confidence (MT). However, QQ plots (Appendix 11.) demonstrated minimal variation and transformation of data was deemed inappropriate due to

influencing changing relationships to original units of measurement within the established measures (Grissom, 2000). Therefore, normality was assumed.

A principle components analysis was conducted regarding ASC measurement due to its creation for the purpose of this study and no established reliability. Only one component had an eigenvalue above the Kaiser criterion of 1, explaining 44.25% of the variance amongst items. This is demonstrated in Table 1. (Appendix 12. for scree plot).

Table 1.
Summary of principle component analysis for the seven item ASC scale (N = 135)

	Component	Communality
I feel my studies this year are going really well	**.76**	.58
I am satisfied with my academic progress	**.78**	.61
I am struggling to keep up with the demands at university	**.66**	.43
I feel I am not improving my academic skills and ability	**.72**	.52
I feel I am able to make the most out of my time at university	**.57**	.33
I always try my best when it comes to academia	**.46**	.21
I feel I am not reaching my full academic potential	**.65**	.42
Eigenvalue	3.1	
Percentage Variance	44.25	

Note. Factor loadings over .4 appear in bold.

Table 2. displays descriptive statistics for ASC, MT and SDT scales. Reliability analyses were conducted, those over 0.7 considered acceptable (George and Mallery, 2017).

Table 2.
Scores on ASC, MT and SDT

Measures	*M*	*(SD)*	*Number of items on scale*	Cronbach's alpha [95% CI]
Academic Self-Concept (ASC)	3.31	(0.66)	7	.78 [.72, .83]
Mental Toughness (MT)	3.13	(0.52)	48	.94 [.92, .95]
MT: Challenge	3.26	(0.63)	8	.80 [.74, .84]
MT: Commitment	3.22	(0.57)	11	.81 [.76, .85]
MT: Control	2.99	(0.57)	14	.81 [.76, .85]
MT: Emotional Control	2.76	(0.61)	7	.62 [.52, .71]
MT: Control of Life	3.21	(0.67)	7	.79 [.73, .84]
MT: Confidence	3.12	(0.60)	15	.85 [.81, .89]
MT: Confidence in Abilities	2.96	(0.68)	9	.84 [.79, .88]
MT: Interpersonal Confidence	3.36	(0.73)	6	.76 [.69, .82]
Self-Determination (SDT)	4.78	(0.76)	21	.89 [.86, .91]
SDT: Autonomy	4.51	(0.88)	7	.75 [.69, .81]

SDT: Competence	4.38	(0.98)	6	.75 [.68, .81]
SDT: Relatedness	5.31	(0.81)	8	.78 [.71, .83]

Note. *N* = 135. CI = Confidence interval. Above displays means and standard deviations for each measure, calculated from each individual mean response across all items.
ASC and MT scales used a Likert scale from 1 (strongly disagree) to 5 (strongly agree) with 3 suggesting 'neither agree nor disagree'.
Response format for SD was 1 (not true at all) to 7 (very true), with 4 representing 'somewhat true'.

As reflected in Table 2., acceptable internal consistency was found except for subscale emotional control (MT), however this finding was reflected in previous methodological evaluations. Participants (*N* = 135) on average scored 3.31 on ASC, a slightly above neutral scoring of 'neither agree or disagree', additionally exemplified in MT findings (*M* = 3.13). SDT means were higher than average (*M* = 4.78), indicating students responded 'true (5)' most of the time. However, this measure had greater variance in responses than other constructs.

To establish any significant relationships between variables, a Pearson's bivariate correlation was conducted regarding academic grades from years one and two and all scales (Table 3.), followed by another Pearson's bivariate correlational analysis to reveal additional relationships with ASC (Table 4.).

Significant positive relationships were found between year one grades and ASC, commitment, autonomy and competence. Relationship with ASC produced a moderate effect size, while commitment, autonomy and competence effects were just below moderate (Cohen, 1988). Slight negative correlations were found with emotional control and confidence in abilities however were non-significant. Significant positive relationships were also found between second year grades and ASC (revealing a large effect size), commitment, control of life, SDT and all SDT subscales, producing moderate effects (Cohen, 1988). A significant correlation (large effect size) was also found between year one and two grades (Cohen, 1988).

Table 3.
Pearson Correlation Matrix for variables grades (years one and two), ASC, MT, SDT and subscales

	Year 1 Grades	Year 2 Grades
Year 1 Grades	-	.66**
Academic Self-Concept (ASC)	.31**	.51**
Mental Toughness (MT)	.09	.23
MT: Challenge	.07	.20
MT: Commitment	.23*	.27*
MT: Control	.06	.22
MT: Emotional Control	-.06	.09
MT: Control of Life	.15	.27*
MT: Confidence	.00	.14

MT: Confidence in Abilities	-.06	.16
MT: Interpersonal Confidence	.09	.06
Self-Determination (SDT)	.18	.40**
SDT: Autonomy	.22*	.40**
SDT: Competence	.25*	.36**
SDT: Relatedness	.03	.33*

Note. *N* (Year 1 grades) = 89. *N* (Year 2 grades) = 57. Two-tailed probability. **p* < .05 **p < .01.

For Table 4., all correlations were statistically significant, producing no effect size below moderate and continually demonstrating large effect sizes (Cohen, 1988). Relationships between constructs and their subscales were highest (as expected), however large correlations were also demonstrated between ASC and SDT (*r* = .64), ASC and MT (*r* = .60), MT and SDT (*r* = .76) and ASC and competence (SDT) (*r* = .70).

Each correlation was assessed for approximately linear relationships before correlational analyses. Figures 1, 2 and 3 evidence linear bivariate relationships between main scales.
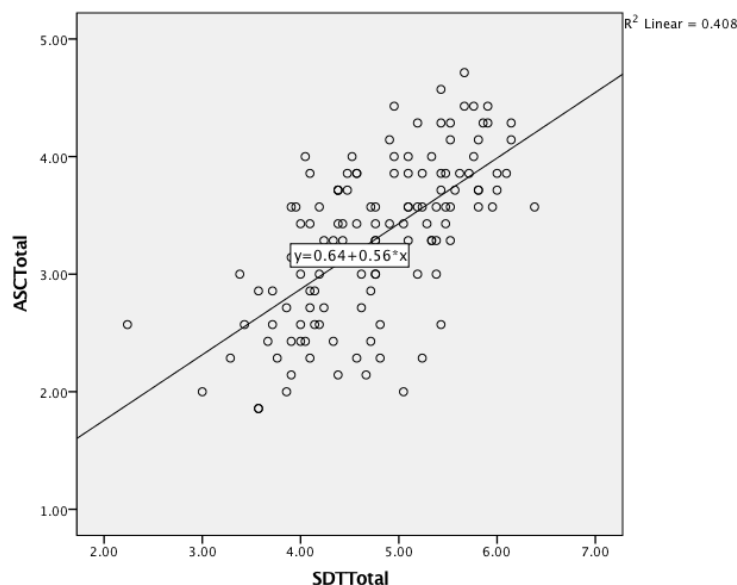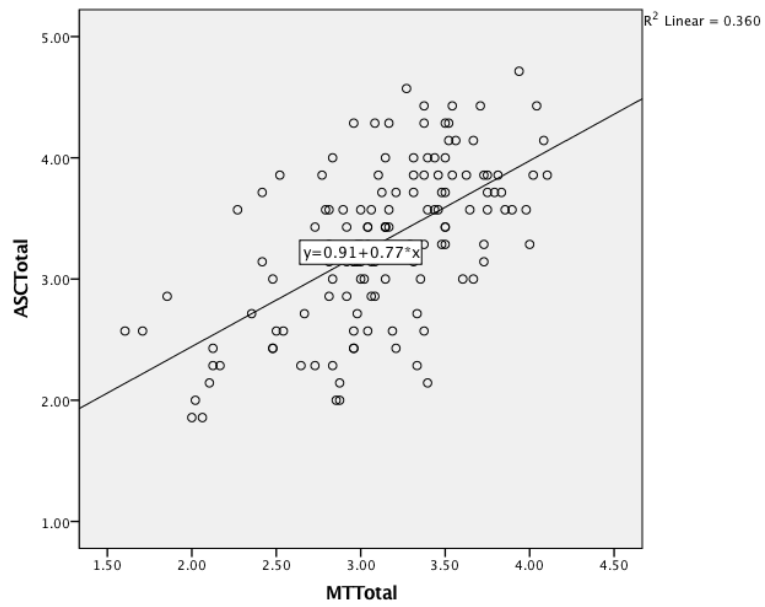

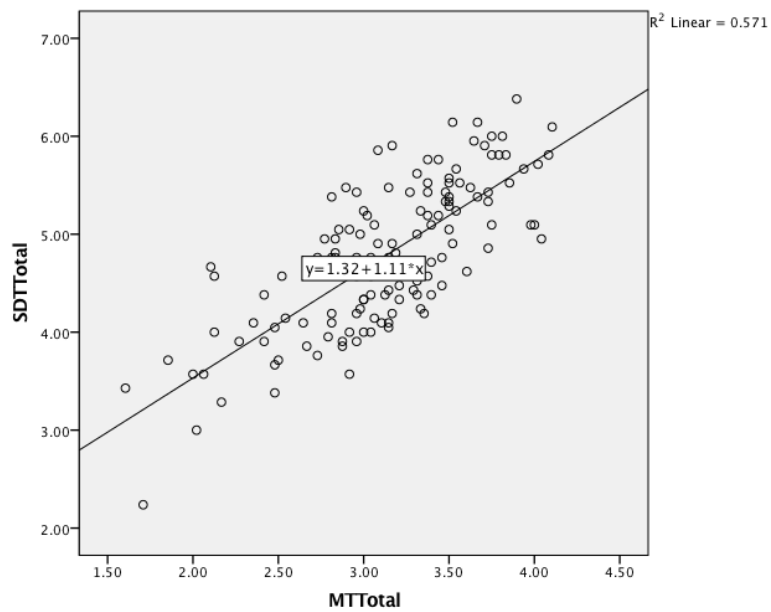**Figure 1. ASC and SDT correlation**

Figure 2. ASC and MT correlation

Figure 3. SDT and MT correlation

Table 4.
Pearson Correlation Matrix for variables ASC, MT and SDT alongside subscales

	Mental Toughness	Challenge	Commitment	Control	Emotional Control	Control of Life	Confidence	Confidence in Abilities	Interpersonal Confidence	Self-Determination	Autonomy	Competence	Relatedness
Academic Self-Concept	.60**	.47**	.60**	.56**	.39**	.59**	.48**	.49**	.30**	.64**	.53**	.70**	.43**
Mental Toughness	-	.80**	.85**	.92**	.75**	.88**	.91**	.86**	.67**	.76**	.66**	.73**	.57**
Challenge	-	-	.65**	.64**	.50**	.62**	.63**	.58**	.50**	.62**	.58**	.57**	.46**
Commitment	-	-	-	.72**	.50**	.76**	.64**	.62**	.45**	.65**	.57**	.68**	.44**
Control	-	-	-	-	.87**	.89**	.81**	.82**	.52**	.70**	.59**	.66**	.55**
Emotional Control	-	-	-	-	-	.55**	.67**	.68**	.42**	.54**	.48**	.48**	.43**
Control of Life	-	-	-	-	-	-	.75**	.76**	.48**	.68**	.56**	.68**	.53**
Confidence	-	-	-	-	-	-	-	.90**	.80**	.67**	.58**	.64**	.53**
Confidence in Abilities	-	-	-	-	-	-	-	-	.46**	.64**	.55**	.61**	.51**
Interpersonal Confidence	-	-	-	-	-	-	-	-	-	.49**	.42**	.47**	.38**
Self-Determination	-	-	-	-	-	-	-	-	-	-	.85**	.87**	.86**

												.62**	.58**
Autonomy	-	-	-	-	-	-	-	-	-	-	-		
Competenc e	-	-	-	-	-	-	-	-	-	-	-	-	.64**
Relatednes s	-	-	-	-	-	-	-	-	-	-	-	-	-

Note. *N* = 135. Two-tailed probability. **p < .01

To assess differences in ASC across undergraduate study, a 1x3 one-way independent ANOVA was conducted with independent variable year group and dependent variable ASC (Table 5.). Similar differences were assessed for MT (Table 6.) and SDT (Table 7.). Homogeneity of variance was assessed using the Levene statistic and was found to be acceptable.

Table 5.

Means, standard deviations and confidence interval scores for ASC across years one (N = 46), two (N = 32) and three (N = 57)

	M	*(SD)*	95% CI	
			LB	*UB*
Year 1 ASC	3.37	(0.60)	3.20	3.55
Year 2 ASC	3.01	(0.66)	2.77	3.25
Year 3 ASC	3.42	(0.67)	3.24	3.60

Note. CI = confidence interval; *LB = lower bound. UB = upper bound*

A significant main effect of ASC over the degree was found, $F(2,132) = 4.50$, $p = .013$, $\eta p2 = .064$. A Tukey post hoc test shown statistically significant differences in ASC from years one to two, $t(78) = 0.36$, $p = .041$, 95% CI [0.01, 0.72], and two to three, $t(103) = -0.41$, $p = .013$, 95% CI [-0.75, -0.07], indicating ASC diminishing in second year and rising in final year (accepting Hypothesis 2). Differences between years one and two produced a slightly above medium effect size ($d = .57$) while differences across years two and three yielded a medium to large effect ($d = .62$) (Leech et al., 2015) (see Figure 4.).
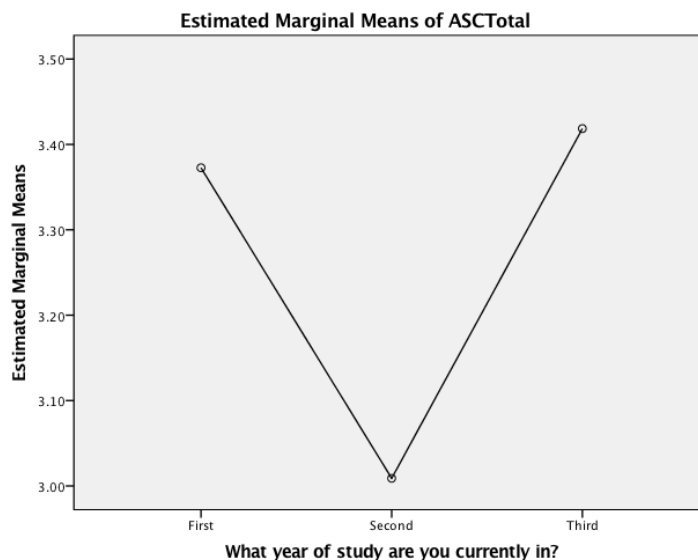

Figure 4. ASC means across years one, two and three

Table 6.

Means, standard deviations and confidence interval scores for MT across years one, two and t

	M	*(SD)*	95% CI	
			LB	*UB*
Year 1 MT	3.02	(0.50)	2.87	3.16
Year 2 MT	3.10	(0.56)	2.90	3.30
Year 3 MT	3.23	(0.50)	3.10	3.36

Note. CI = confidence interval; *LB = lower bound. UB = upper bound*

Table 7.

Means, standard deviations and confidence interval scores for SDT across years one (N = 46), two (N = 32) and three (N = 57)

	M	*(SD)*	95% CI	
			LB	*UB*
Year 1 SDT	4.67	(0.69)	4.47	4.88
Year 2 SDT	4.74	(0.68)	4.49	4.98
Year 3 SDT	4.88	(0.84)	4.66	5.11

Note. CI = confidence interval; *LB = lower bound. UB = upper bound*

Non-significant effects were found for the development of SD ($F(2,132) = 1.05$, $p = .352$, $\eta p2 = .016$) and MT ($F(2,132) = 2.30$, $p = .104$ $\eta p2 = .034$) across the degree, rejecting Hypothesis 3. However, a slight increase across the years is still demonstrated.

A repeated measures t-test was conducted to assess developments in grades from years one to two. Findings were non-significant, ($t(56) = 0.34$, $p = .732$, 95% CI [-1.17, 1.65]) with a smaller than typical effect size ($d = 0.04$; Leech et al., 2015). However, strong correlations between first and second year grades were found (.66).

Due to initial correlational relationships amongst variables, a series of multiple regression analyses were conducted using the 'enter' method. MT, SD and competence were assessed in relation to ASC (Table 8.), ASC, autonomy, competence and commitment for year one grades (Table 9.) and ASC, SD, autonomy and competence for second year grades (Table 10.).

Alongside this, further multiple regression analyses were conducted to assess relationships between predictors based on aforementioned literature. MT, commitment, control and autonomy were assessed for ASC (Table 11.), year one grades (Table 12.) and year two grades (Table 13.).

Table 8.

Summary of multiple linear regression for measures MT and subscale competence in predicting ASC

Variable	*B*	β	*t*	Sig. (p)
Constant	0.88			
Mental Toughness	0.24	0.19	2.08	.039
Competence	0.39	0.57	6.39	<.001

Note. R^2 = .72, *Adjusted* R^2 = .50

SDT did not significantly contribute to prediction of ASC so was removed and the regression was conducted again. Both remaining variables significantly predicted ASC, the strongest being competence with a one-point increase associated with a 0.39 ASC increase. This regression produced a 'much larger than normal' effect size (Leech et al., 2015). The data met the assumption for independent errors (Durbin-Watson value = 1.94) and further multicollinearity assumptions were tested (see Appendix 13.).

Table 9.

Summary of multiple linear regression for ASC predicting year one grades

Variable	*B*	β	*t*	Sig. (p)
Constant	54.02			
ASC	3.42	0.31	3.04	.003

Note. R^2 = .31, *Adjusted* R^2 = .09

As before, subscales autonomy, competence and commitment were initially assessed however were removed due to influential insignificant findings. Remaining variable ASC significantly predicted first year academic performance, with every one-point increase relating to a 3.42 increase in year one grades. This regression produced a small effect size (Leech et al., 2015), however was very close to medium. The data met the assumption for independent errors (Durbin-Watson value = 1.82) and further multicollinearity assumptions were tested (see Appendix 14.).

Table 10.

Summary of multiple linear regression for ASC and autonomy in predicting year two grades

Variable	*B*	β	*t*	*Sig. (p)*
Constant	48.11			
Autonomy	1.01	0.15	1.03	.309
ASC	3.98	0.42	2.91	.005

Note. R^2 = .52, *Adjusted* R^2 = .24

Again, SD and subscale competence were removed due to influential insignificant findings. Remaining, only ASC significantly predicted academic performance, with every one-point increase here reflected by 3.98 increase in year two grades. This produced a large effect size (Leech et al., 2015). The data met the assumption for independent errors (Durbin-Watson value = 2.06) and further multicollinearity assumptions were tested (see Appendix 15.).

Table 11.

Summary of multiple linear regression for subscales control, commitment and autonomy in predicting ASC

Variable	*B*	β	*t*	*Sig. (p)*
Constant	0.63			
Control	0.21	0.18	1.74	.084
Commitment	0.40	0.35	3.51	.001
Autonomy	0.17	0.23	2.71	.008

Note. R^2 = .65, *Adjusted* R^2 = .42

When regarding predictors often suggested in literature, MT, control, commitment and autonomy were all examined regarding their predictability on ASC. Variable MT was removed as it did not significantly contribute. Both commitment and autonomy significantly predicted ASC, with every one-point increase in most influential commitment reflected by 0.40 increase in ASC. This regression produced a large effect size (Leech et al., 2015). The data met the assumption for independent errors (Durbin-Watson value = 2.01) and further multicollinearity assumptions were tested (see Appendix 16.).

Table 12.

Summary of multiple linear regression for MT, commitment and autonomy in predicting year one grades

Variable	*B*	β	*t*	*Sig. (p)*

Variable	B	β	t	Sig. (p)
Constant	58.46			
MT	-9.60	-0.65	-2.84	.006
Commitment	7.39	0.57	2.86	.005
Autonomy	2.89	0.34	2.22	.029

Note. R^2 = .38, *Adjusted R^2* = .11

Additional analyses were conducted on MT, control, commitment and autonomy in their prediction of year one grades. Variable control was removed as it did not significantly contribute and the test was ran again. All remaining variables significantly predicted year one academic grades, with every one-point increase in biggest contributors MT and commitment associated with -9.60 and 7.39 increase in year one grades respectively. This produced a medium effect size (Leech et al., 2015). The data met the assumption for independent errors (Durbin-Watson value = 1.77) and further multicollinearity assumptions were tested (see Appendix 17.).

Table 13.
Summary of multiple linear regression for subscales control, commitment and autonomy in predicting year two grades

Variable	B	β	t	Sig. (p)
Constant	56.69			
MT	-6.17	-0.48	-1.69	.098
Commitment	3.53	0.33	1.42	.162
Autonomy	3.89	0.57	2.90	.005

Note. R^2 = .45, *Adjusted R^2* = .16

Finally, an analysis of the effects of MT, control, commitment and autonomy were conducted on their relation to academic performance in second year. Variable control was removed as it did not significantly contribute. Only autonomy produced statistically significant results, every one-point increase associated with a 3.89 increase in second year grades. The effect size for this regression was medium (Leech et al., 2015). The data met the assumption for independent errors (Durbin-Watson value = 2.03) and further multicollinearity assumptions were tested (see Appendix 18).

It is important to notice only slightly different R^2 values than those obtained by multiple regression based on observed sample correlations. Within correlational findings the possibility to capitalise on chance is present, however similarities with R^2 values acquired by theoretical predictors could therefore demonstrate stronger findings within correlational-led predictors. This is demonstrated for findings of Table 8. and Table 11., Table 9. and Table 12., and Table 10. and Table 13.

Finally, to establish any gender differences in MT, SDT, ASC and grades, independent t-tests were conducted. ASC gender differences were non-significant

(*t*(127) = 0.46, *p* = .644, 95% CI [-0.20, 0.32]) with an effect size of *d* = 0.09 (smaller than typical (Leech et al. (2015)). Similarly, non-significant gender differences were found for year one (*t*(84) = -0.12, *p* = .906, 95% CI [-3.77, 3.35]) and two grades (*t*(53) = 0.19, *p* = .848, 95% CI [-3.53, 4.27]). Non-significant gender differences were found for SDT (*t*(127) = 0.16, *p* = .875, 95% CI [-0.27, 0.32]) and MT (*t*(127) = 1.41, *p* = .160, 95% CI [-0.06, 0.34]).

Discussion

The current study found both MT and SD to predict undergraduate success, however a weighting of the comparative influence proved difficult. Unexpectedly, ASC dominated predictive findings of grade outcome. As hypothesised, ASC shown significant improvements across years one to three, however MT and SDT failed to do so. Gender differences were assessed, however no distinctions arose. Means of MT were slightly lower than those in literature, with a 3.13 found reflecting 3.45 previously suggested (Clough et al., 2015). Similarly, a 4.78 mean found within SD reflected higher than those often found (4.16) (Ciyin and Erturan-Ilker, 2014).

With literature failing to evidence predictive investigations using MT or SD in terms of ASC, variables suggested to predict academic grades were examined due to initial conceptualisation of directional relationship of ASC and grades. The findings suggest both commitment (MT) and autonomy (SDT) collectively account for 72% of variance within ASC, not only providing preliminary research into ASC predictability but also strengthening ASC and grade relationships (Marsh and Martin, 2011) due to similar predictors within the academic domain. Alongside this, these findings further confirm the incorporation of both concepts when initially defining academic success. No MT or SD advantage was explicitly found, however percentage of variance explained by the combination of these findings was over and above anything found in previous research (O'Reilly, 2014; Lin et al., 2017), confirming their presence in the prediction of ASC.

When further assessing these variables in terms of year one grades, MT, commitment (MT) and autonomy (SDT) collectively accounted for 31% predictability, with MT and its subcomponents proving somewhat defiant over autonomy (SDT). These findings suggest a MT advantage when comparing predictive influence on year one grades, while echoing previous findings suggesting importance of proposed variables within literature (O'Reilly, 2014; St Clair-Thompson, 2014; Lin et al., 2017). Comparatively, when regarding year two grades only autonomy (SDT) significantly predicted academic output, accounting individually for 45% predictability. While echoing previous findings (O'Reilly, 2014), this further enlightens the previously debated predictability of autonomy on academic success where Bronson (2016) failed to find significant results. However, Bronson (2016) did suggest providing autonomy-supportive environments to foster academic improvements and so the current findings further strengthen this recommendation.

Both MT and SDT clearly demonstrate fair company within the prediction of ASC and grades, with a MT advantage in predictability of ASC and year one grades and a clear autonomy-led SDT advantage in prediction of grades in year two. This reflects strong correlations of MT and SDT scales (.76), further defining proposed similarities of the two constructs in terms of academic outcomes (Gucciardi and Mallett, 2010; Mallett and Coulter, 2011; Mahoney et al., 2014a).

Alongside this, correlations proved interesting in initial analyses with ASC, SD, MT, commitment (MT), competence (SDT) and autonomy (SDT) all noteworthy due to strong positive correlations found between variables. When predicting ASC, both MT and competence (SDT) significantly predicted ASC, accounting for 72% of variation. While this evidences both MT and SD influences, correlational and literature driven regressions failed to cohesively imply predictors of ASC outcomes, questioning the accuracy of predictive understandings previously proposed. However, the influence of both MT and SDT constructs in prediction of ASC is evidently clear and positioning of both constructs in educational enquiry is confirmed.

However, when predicting grades a surprising result was found – high correlations with ASC over and above any MT or SD contribution led to dominance of this variable in predicting grade outcome, accounting for 31% and 52% of year one and two grades respectively. This finding again confirms positioning of ASC within academic success literature as previously debated (Marsh and Martin, 2011) while implicating developments in ASC to foster grade outcomes. However, due to previous criticisms of difficulty interpreting direction of effect (Guay et al., 2010) the prediction directionality is still unclear; while ASC clearly predicts grade outcome here, further research into the reverse of this relationship is key to truly assess ASC and grade directionality.

However, while no MT or SD advantage was found in prediction of ASC or grade outcome specifically, autonomy (SDT) evidenced explicit presence within prediction of outcomes, with this variable found to predict ASC, year one and year two grades for all regressions based on previous literature, alongside year two grades led by correlational assessment. An autonomy advantage in SD predictions was undoubtedly present, confirming the positioning of autonomy within academic prediction and further encouraging autonomy-supportive environments to truly foster academic outcomes as previously recommended (Ryzin et al., 2009; O'Reilly, 2014).

This being said, both MT and SD predictors did indeed show worth in prediction of ASC and grades, and so while hypothesis one could not be answered entirely both constructs further demonstrate non-cognitive presence within academia. Alongside this, findings further implicated both concepts worth within non-sporting literature and so findings of the current study prove enlightening with regard to non-cognitive applicability outside of sporting domains often dominant (Gerber et al., 2012; Sun et al., 2017).

While key aims reflected comparative predictability of MT and SDT, the significant developments of these constructs alongside ASC advances was also key to assess. Both MT and SDT failed to find significant improvements over the degree period as often proposed within literature (Deci and Ryan, 2002; Marchant et al., 2009), however although non-significant general improvements were demonstrated for both constructs. However, further rooting ASC as central within this debate, ASC found significant differences from years one to two, and two to three. While initially ASC decreases, ASC then increases across years two to three ending over and above initial ASC projective scores as previously indicated (Baumeister et al., 2013). While these findings generally accept hypothesis two, the true increase of ASC does not appear to be extensively noteworthy and although evidences ASC dominance over MT and SD contributions, raises further questions of predictive developments outside the statistical realm. This being said, findings of initial decreases followed by increases from first to third year of study reflect that previously found within literature when regarding grades (Grove and Wasserman, 2004; Brändle and Lengfeld, 2017),

further demonstrating the relationship and apparent unity of ASC and grade outcome in the conceptualisation of academic success.

In addition to ASC improvements, a t-test was conducted to assess differences and developments of grade outcome across years one to two. No significant differences were found, contrasting previous literature proposing reductions from years one to two followed by general improvements after year three (Grove and Wasserman, 2004; Brändle and Lengfeld, 2017). This unfortunately questions previously suggested relationships between ASC and grade outcome, demonstrated by different projections and changes over time. However, slight decreases in means from years one to two were found as per aforementioned literature, and dominance of ASC in this branch of investigation possibly demonstrates an ASC advantage over grade outcome within the output of academic success as a unified concept. This being said, access to third year grades was not available here, and so true trajectory of grade development is still unexplained.

Finally, for academic success constructs no significant gender differences were found contrasting previous literature indicating female advantages (Ismail and Othman, 2006; Sheard, 2009; Khwaileh and Zaza, 2011). This finding was also reflected within MT and SDT investigations, with no gendered advantage found as previously reported in which males performed better on MT (Nicolls et al., 2009; Crust et al., 2014) and females on SD (Vecchione et al., 2014). These findings may collectively demonstrate developments in progressive gender identifications and diversity (Westbrook and Saperstein, 2015), however these findings only mark the beginning of such investigations if representative of such change and awareness of such identification is key for future explorations.

When assessing acceptance of hypotheses, no MT or SD advantage was found with the prediction of academic outcomes; however, the use of non-cognitive predictors in assessing academia was further promoted as previously suggested (Chamorro-Premuzic and Furnham, 2003; Ruffing et al., 2015; McGeown et al., 2016; Lin et al., 2017) and an understanding of their implications within prediction of outcomes allows for more targeted intervention within undergraduate populations to develop academic fulfilment (McGeown et al., 2016). This being said, MT conceptualisations and evaluations produced by Clough et al. (2002) additionally provide development techniques, personally tailored to suit identified MT strengths and weaknesses. The ability to develop MT is demonstrated in comparison to no such intervention implication offered from original SD concepts. Corresponding interventions can therefore be implemented to encourage MT growth and in turn academic outcomes, possibly demonstrating this concepts deeper stance within the current direction of academic investigations. However, the use of such scales and therefore implementation of guidance is approached with caution; while great outcomes are consistently found, the current research further exemplified poor reliability of the emotional control (MT) scale in accordance with previous investigations. While the concept has great implication, assessment of reliability is recommended to further clarify clearly incoherent understandings.

Additionally, an ASC dominance within prediction of grade outcome was clear, and so further research into not only the reciprocity of both ASC and grade outcomes, but additionally ASC as a key predictor behind academic success is recommended. Alongside this, the evidenced reduction of ASC from years one to

two demonstrate a clear need for implemented intervention to enhance ASC projections during this period, further evidencing presence of non-cognitive influences on ever-changing academic outcomes. Again, as previously mentioned the relationship of ASC and grades is clearly influential and so more investigations into directionality of this relationship and the extent to which this association may further define academic success is advised. While findings of no gender differences proved enlightening and possibly reflective of a progressively identifying nation (Westbrook and Saperstein, 2015), contradiction to previous findings require further exploration as to true gendered underpinnings of ASC, grade, MT and SD influences.

However, while providing effective guidance for future research directions the current research does not come without limitation. While ASC was demonstrated to significantly increase over years one to three, academic grades were only collected from years one and two (due to no participants from post-graduate levels). While no significant differences were found, the true development of grade outcome could not be assessed across the degree period as often investigated (Brändle and Lengfeld, 2017) and so further research into true grade trajectory is advised.

Alongside this, while ASC was continually found to be of interest, the scale used to measure this concept has not been validated or deemed reliable aside from within this study. While influenced by previously validated questionnaires (Reynolds, 1998; Liu et al., 2005) and boasting excellent Cronbach's alpha levels alongside conduction of a principle components analysis, psychometric properties were not established and so further testing is required to fully ensure applicability and reliability across various samples and sizes.

An additional limitation of the current research is the parametric nature of data analysed – it could be argued the data of the current study was not normally distributed due to Kolmogorov-Smirnov and Shapiro-Wilk outputs, although histograms and Q-Q plots were extensively assessed to ensure general normality and minimal violation.

Limitations aside, the current study evidently provides educational academia with a platform to extend predictive investigations into the development of academic success when conceptualised by ASC and grade outcome. With indication of non-cognitive presence in prediction of both ASC and grades, MT and SDT show comparable yet unmistakeable worth within understanding of academic outcomes, and so further development of intervention regarding these concepts is clearly worthwhile. Alongside this, the dominance of ASC within this study evidences clear relationships with academic attainment, confirming reciprocity and relationships somewhat questioned within literature. The contribution of this study therefore provides a springboard for future research aiming to elucidate the variance in academic success, in a hope to not only improve grade outcomes but crucially to develop and grow self-worth and concept of undergraduate students.

References

Baumeister, R., Campbell, J., Krueger, J., and Vohs, K. (2003) 'Does high self-esteem cause better performance, interpersonal success, happiness, or healthier lifestyles?' *Psychological Science in the Public Interest,* 4(1) pp. 1–44.

Biau, D., Kernéis, S. and Porcher, R. (2008) 'Statistics in Brief: The Importance of Sample Size in the Planning and Interpretation of Medical Research.' *Clinical Orthopaedics and Related Research,* 466(9) pp. 2282-2288.

Brändle, T. and Lengfeld, H. (2017) 'Drifting apart or converging? Grades among non-traditional and traditional students over the course of their studies: a case study from Germany.' *Higher Education,* 73(1) pp. 227-244.

Bronson, S. (2016) 'Autonomy support environment and autonomous motivation on nursing student academic performance: An exploratory analysis.' *Nurse Education Today,* 44(1) pp. 103-108.

Carifio, J. and Perla, R. (2007) 'Ten Common Misunderstandings, Misconceptions, Persistent Myths and Urban Legends about Likert Scales and Likert Response Formats and their Antidotes.' *Journal of Social Sciences,* 3(3) pp. 106-116.

Chamorro-Premuzic, T. and Furnham, A. (2003) 'Personality predicts academic performance: Evidence from two longitudinal university samples.' *Journal of Research in Personality,* 37(4) pp. 319-338.

Chen, B., Vansteenkiste, M., Beyers, W., Boone, L., Deci, E., Van der Kaap-Deeder, J., Duriez, B., Lens, W., Matos, L., Mouratidis, A., Ryan, R., Sheldon, K., Soenens, B., Van Petegem, S. and Verstuyf, J. (2015) 'Basic psychological need satisfaction, need frustration, and need strength across four cultures.' *Motivation and Emotion,* 39(1) pp. 216-236.

Ciyin, G. and Erturan-Ilker, G. (2014) 'Student Physical Education Teachers' Well-Being: Contribution of Basic Psychological Needs.' *Journal of Education and Training Studies,* 2(3) pp. 44-51.

Clough, P., Earle, K. and Sewell, D. (2002) 'Mental toughness: The concept and its measurement.' *In* Cockerill, I. (ed.) *Solutions in sport psychology*. London: Thomson Learning, pp. 32-46.

Clough, P., Perry, J., Crust, L., Strycharczyk, D. and Rowlands, C. (2015) *The MTQ48 Technical Manual.* Unknown place of publication. AQR International. [Online] [Accessed 7th April 2018] http://civilsociety360.co.uk/sites/default/files/The%20MTQ48%20Technical%20Manual%20-%20Final%202015.pdf

Cohen, J. (1988) *Statistical power analysis for the behavioral sciences*. 2nd ed., New Jersey: Lawrence Earlbaum Associates.

Conard, M. (2006) 'Aptitude is not enough: How personality and behaviour predict academic performance.' *Journal of Research in Personality*, 40(1) pp. 339-346.

Crust, L. (2008) 'A review and conceptual re-examination of mental toughness: Implications for future researchers.' *Personality and Individual Differences,* 45(1) pp. 576-583.

Crust, L. and Clough, P. (2005) 'Relationship between mental toughness and physical endurance.' *Perceptual and Motor Skills,* 100(1) pp. 192-194.

Crust, L., Earle, K., Perry, J., Earle, F., Clough, A. and Clough, P. (2014) 'Mental toughness in higher education: Relationships with achievement and progression in first-year university sports students.' *Personality and Individual Differences,* 69(1) pp. 87-91.

Crust, L. and Swann, C. (2011) 'Comparing two measures of mental toughness.' *Personality and Individual Differences,* 50(1) pp. 217-221.

Deci, E. and Ryan, R. (1985) *Intrinsic motivation and self-determination in human behaviour.* New York: Plenum.

Deci, E. and Ryan, R. (2000) 'The 'what' and 'why' of goal pursuits: Human needs and the self-determination of behaviour.' *Psychological Inquiry,* 11(1) pp. 227-268.

Deci, E. and Ryan, R. (2002) *Handbook of self-determination research.* New York: University Rochester Press.

Deci, E. and Ryan, R. (2008) 'Self-Determination Theory: A Macrotheory of Human Motivation, Development, and Health.' *Canadian Psychology,* 49(3) pp. 182-185.

Deci, E., Vallerand, R., Pelletier, L. and Ryan, R. (1991) 'Motivation and Education: The Self-Determination Perspective.' *Educational Psychologist,* 26(3-4) pp. 325-346.

Dewhurst, S., Anderson, A., Cotter, G., Crust, L. and Clough, P. (2012) 'Identifying the cognitive basis of mental toughness: Evidence from the directed forgetting paradigm.' *Personality and Individual Differences,* 53(1) pp. 587-590.

Gagné, M. (2003) 'The role of autonomy support and autonomy orientation in prosocial behavior engagement.' *Motivation and Emotion,* 27(1) 199-223.

George, D. and Mallery, P. (2017) *IBM SPSS statistics 23 step by step: a simple guide and reference.* 14th ed., Boston: Pearson Education.

Gerber, M., Kalak, N., Lemola, S., Clough, P., Perry, J., Püshe, E., Holsboer-Trachsler, E. and Brand, S. (2012) 'Are Adolescents With High Mental Toughness Levels More Resilient Against Stress?' *Stress and Health,* 29(2) pp. 164-171.

Gottfredson, L. (2002) 'Where and why g matters: not a mystery.' *Human Performance,* 15(1) pp. 25-46.

Green, J., Liem, G., Martin, A., Colmar, S., Marsh, H. and McInerney, D. (2012) 'Academic motivation, self-concept, engagement, and performance in high school: Key processes from a longitudinal perspective.' *Journal of Adolescence,* 35(1) pp. 1111-1122.

Grissom, R. (2000) 'Heterogeneity of variance in clinical data.' *Journal of Consulting and Clinical Psychology,* 68(1) pp. 155-165.

Grove, W. and Wasserman, T. (2004) 'The life cycle pattern of collegiate GPA: Longitudinal cohort analysis and grade inflation.' *The Journal of Economic Education,* 35(2) pp. 162-174.

Guay, F., Ratelle, C., Roy, A. and Litalien, D. (2010) 'Academic self-concept, autonomous academic motivation, and academic achievement: Mediating and additive effects.' *Learning and Individual Differences,* 20(1) pp. 644-653.

Gucciardi, D., Hanton, S. and Mallett, C. (2012) 'Progressing measurement in mental toughness: A case example of the Mental Toughness Questionnaire 48.' *Sport, Exercise, and Performance Psychology,* 1(3) pp. 194-214.

Gucciardi, D, Hanton, S., Mallett, C. and Temby, P. (2015) 'The concept of mental toughness: tests of dimensionality nomological network, and traitness.' *Journal of Personality,* 83(1) pp.26-44.

Gucciardi, D. and Mallet, C. (2010) 'Understanding and developing mental toughness in sport.' *In* Hanrahan, S and Anderson, M. (ed.) *Handbook of applied sport psychology*. London: Routledge, pp. 547-556.

Ismail, N. and Othman, A. (2006) 'Comparing university academic performances of HSC students at the three art-based facilities.' *International Education Journal,* 7(5) pp. 668-675.

Kappe, F. and van de Flier, H. (2010) 'Using multiple and specific criteria to assess the predictive validity of the Big Five personality factors on academic achievement.' *Journal of Research in Personality,* 44(1) pp. 142-145.

Khwaileh, F. and Zaza, H. (2011) 'Gender differences in academic performance among undergraduates at the University of Jordan: are they real or stereotyping?' *College Student Journal,* 45(3) pp. 633-648.

Kornilov, S., Grigorenko, E., and Smirnov, S. (2009) 'A longitudinal study of academic, creative, and practical abilities as preconditions of success in learning.' *Issues in Psychology,* 5(1) pp. 138–149.

Leech, N., Barrett, K. and Morgan, G. (2015) *IBM Statistics for intermediate statistics: use and interpretation*. 5th Ed., London: Routledge.

Lin, Y., Clough, P., Welch, J. and Papageorgiou, K. (2017) 'Individual differences in mental toughness associate with academic performance and income.' *Personality and Individual Differences,* 113(1) pp. 178-183.

Liu, W., Wang, C. and Parkins, E. (2005) 'A longitudinal study of students' academic self-concept in a streamed setting: The Singapore context.' *British Journal of Educational Psychology,* 74(4) pp. 567-586.

Mahoney, J., Gucciardi, D., Ntoumanis, N. and Mallet, C. (2014a) 'Mental Toughness in Sport: Motivational Antecedents and Associations With

Performance and Psychological Health.' *Journal of Sport and Exercise Psychology,* 36(1) pp. 281-292.

Mahoney, J., Ntoumanis, N., Gucciardi, D., Mallett, C., and Stebbings, J. (2016) 'Implementing an Autonomy-Supportive Intervention to Develop Mental Toughness in Adolescent Rowers.' *Journal of Applied Sport Psychology*, 28(2) pp. 199-215.

Mahoney, J., Ntoumanis, N., Mallett, C. and Gucciardi, D. (2014b) 'The motivational antecedents of the development of mental toughness: a self-determination theory perspective.' *International Review of Sport and Exercise Psychology,* 7(1) pp. 184-197.

Mallett, C. and Coulter, T. (2011) 'Understanding and developing the will to win: Perceptions of parents, coaches, and players.' *In* Gucciardi, D. and Gordon, S. (ed.) *Mental toughness in sport: Developments in research and theory.* United Kingdom: Routledge, pp 187-211.

Marchant, D., Polman, R., Clough, P., Jackson, J., Levy, A. and Nicholls, A. (2009) 'Mental Toughness: Managerial and Age Differences.' *Journal of Managerial Psychology,* 24(1) pp. 428-437.

Marsh, H. and Martin, A. (2011) 'Academic self-concept and academic achievement: Relations and casual ordering.' *British Journal of Educational Psychology,* 81(1) pp. 59-77.

McGeown, S., Putwain, D., St Clair-Thompson, H. and Clough, P. (2017) 'Understanding and supporting adolescents' mental toughness in an education context.' *Psychology in the Schools,* 54(2) pp. 196-209.

McGeown, S., St Clair-Thompson, H., and Clough, P. (2016) 'The study of non-cognitive attributes in education: proposing the mental toughness framework.' *Educational Review,* 68(1) pp. 96-113.

Molix, L. and Nichols, C. (2013) 'Satisfaction of basic psychological needs as a mediator of the relationship between community esteem and wellbeing.' *International Journal of Wellbeing,* 3(1) pp. 20-34.

Morosanova, V., Formina, T. and Bondarenko, I. (2015) 'Academic achievement: Intelligence, regulatory, and cognitive predictors.' *Psychology in Russia: State of the Art,* 8(3) pp. 136-156.

Naude, L., Nel, L., van der Watt, R. and Tadi, F. (2016) 'If it's going to be, it's up to me: first-year psychology students' experiences regarding academic success.' *Teaching in Higher Education,* 21(1) pp. 37-48.

Ng, B., Liu, W., and Wang, J. (2016) 'Student Motivation and Learning in Mathematics and Science: A Cluster Analysis.' *International Journal of Science and Maths Education,* 14(1) pp. 1359-1376.

Nicholls, A., Polman, R., Levy, A. and Backhouse, S. (2008) 'Mental toughness, optimism, and coping among athletes.' *Personality and Individual Differences,* 44(1) pp. 1182-1192.

Noels, K., Clement, R. and Pelletier, L. (2001) 'Intrinsic, extrinsic, and integrative orientations of French Canadian learners of English.' *Canadian Modern Language Review,* 57(1) pp. 424-440.

O'Hare, L. and McGuiness, C. (2015) 'The validity of critical thinking tests for predicting degree performance: A longitudinal study.' *International Journal of Educational Research,* 72(1) pp. 162-172.

O'Reilly, E. (2014) 'Correlations among perceived autonomy support, intrinsic motivation, and learning outcomes in an intensive foreign language programme.' *Theory and Practise in Language Studies,* 4(7) pp. 1313-1318.

Perry, J., Clough, P., Crust, L., Earle, K. and Nicholls, A. (2013) 'Factorial validity of the Mental Toughness Questionnaire-48.' *Personality and Individual Differences,* 54(1) pp. 587-592.

Reynolds, W. (1988) 'Measurement of academic self-concept in college students.' *Journal of Personality Assessment,* 52(1) pp. 223-240.

Ricci, L. (2010) 'Adjusted *R*-squared type measure for exponential dispersion models.' *Statistics and Probability Letters,* 80(1) pp. 1365-1368.

Richardson, M., Abraham, C. and Bond, R. (2012) 'Psychological correlates of university students' academic performance: a systematic review and meta-analysis.' *Psychological Bulletin,* 138(1) pp. 353-387.

Ruffing, S., Wach, F., Spinath, F., Brünken, R. and Karbach, J. (2015) 'Learning strategies and general cognitive ability as predictors of gender-specific academic achievement.' *Frontiers in Psychology,* 6:1238, pp. 1-12. [Online] [Accessed on 8th March 2018] DOI:10.3389/fpsyg.2015.01238

Ryan, R. and Deci, E. (2000) 'Self-determination theory and the facilitation of intrinsic, social development, and well-being.' *The American Psychologist,* 55(1) pp. 68-78.

Ryan, R. and Deci, E. (2002) 'Overview of self-determination theory: An organismic dialectical perspective.' *In* Deci, E. and Ryan, R. (ed.) *Handbook of self-determination research.* Rochester: Rochester University Press, pp. 3-33.

Ryzin, M., Gravely, A. and Roseth, C. (2009) 'Autonomy, Belongingness, and Engagement in School as Contributors to Adolescent Psychological Well-Being.' *Journal of Youth and Adolescence,* 38(1) pp. 1-12.

Sheard, M. (2009) 'Hardiness commitment, gender, and age differentiate university academic performance.' *British Journal of Educational Psychology,* 79(1) pp. 189-204.

Sinatra, G. (2005) 'The "warming trend" in conceptual change research: The legacy of Paul R Pintrich.' *Educational Psychology,* 40(2) pp. 107-115.

Spinath, B., Spinath, F., Harlaar, N. and Plomin, R. (2006) 'Predicting school achievement from general cognitive ability, self-perceived ability, and intrinsic value.' *Intelligence,* 34(1) pp. 363-374.

Stamp, E., Crust, L., Swann, C., Perry, J., Clough, P. and Marchant, D. (2015) 'Relationships between mental toughness and psychological wellbeing in undergraduate students.' *Personality and Individual Differences,* 75(1) pp. 170-174.

St Clair-Thompson, H., Bugler, M., Robinson, J., Clough, P., McGeown, S. and Perry, J. (2014) 'Mental toughness in education: exploring relationships with attainment, attendance, behaviour and peer relationships.' *Educational Psychology,* 35(7) pp. 886-907.

Sun, H., Li, W. and Shen, B. (2017) 'Learning in Physical Education: A Self-Determination Theory Perspective.' *Journal of Teaching in Physical Education,* 36(1) pp. 277-291.

Taylor, G., Jungert, T., Mageau, G., Schattke, K., Dedic H., Rosenfield, S. and Koestner, R. (2014) 'A self-determination theory approach to predicting school achievement over time: the unique role of intrinsic motivation.' *Contemporary Educational Psychology,* 39(1) pp. 342-358.

Trenshaw, K., Revelo, R., Earl, K. and Herman, G. (2016) 'Using Self-Determination Theory Principles to Promote Engineering Students' Intrinsic Motivation to Learn.' *International Journal of Engineering Education,* 32(3) pp. 1194-1207.

Vecchione, M., Alessandri, G. and Marsicano, G. (2014) 'Academic motivation predicts educational attainment: Does gender make a difference?' *Learning and Individual Differences,* 32(1) pp. 124-131.

Westbrook, L. and Saperstein, A. (2015) 'New Categories Are Not Enough: Rethinking the Measurement of Sex and Gender in Social Surveys.' *Gender and Society,* 29(4) pp. 534-560.

York, T., Gibson, C. and Rankin, S. (2015) 'Defining and Measuring Academic Success.' *Practical Assessment, Research and Evaluation,* 20(5) pp. 1-20. [Online] [Accessed on 8th March 2018] http://pareonline.net/getvn.asp?v=20&n=5