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INFORMATION SYSTEMS EDUCATION JOURNAL

Grit and the Information Systems Student: A Discipline-Specific Examination of Perseverance and Passion for Long Term Goals

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Abstract

Grit has been highlighted in recent research as a distinct trait believed to be associated with performance and success factors above and beyond those explained by cognitive ability. It focuses on the dedication required to meet long-term goals and is represented by two subscales: consistency of interest and perseverance of effort. The overall goal of the current study is to understand the operation of the grit construct and its relationship with key demographic factors for information systems students specifically. Data was collected from 176 information systems undergraduate and graduate students at a public university in the southeastern United States. Analysis was conducted using structural equation modeling. Individual models were created and examined that included grit and key factors shown in previous research as related to grit: age, GPA, and gender. Additional factors were included related to employment status (full-time, part-time, unemployed) and academic classification (freshman, sophomore, junior, senior, and graduate student). Findings from the analysis of the grit structure in conjunction with these different factors indicate that grit and employment status are related. Individuals that specified they were employed full-time had higher levels of grit. For this group of students, findings revealed some inconsistencies with previous research and the relationship of grit to the additional factors studied, highlighting the need for discipline-specific examinations of construct. A detailed discussion of the results is provided along with implications and suggestions for future research.

Keywords: grit; information systems students; Grit-S; long-term goals; perseverance

1. INTRODUCTION

At the center of research related to the information systems (IS) discipline and higher education, there is the goal of understanding the student to the greatest level possible in hopes of being able to foster progression through academic programs as well as to improve the likelihood of future career success. Research has indicated “30% of students who entered college in the fall of 2014 did not return in the second year” (Lee & Stewart, 2016 p. 2). Additionally, information systems remains a field where supply is not meeting demand in relation to providing individuals to sustain and support the workforce (White, 2016). Academic programs struggle with recruiting and retaining students (Hunsinger, Land, & Chen, 2012) in conjunction with these other factors. As such, it is necessary to continue and strive to better know our current students. One avenue that has not been explored for the IS discipline is to understand information systems students’ level of grit.

Over the past decade, research related to the concept of grit has highlighted usefulness of the construct as a predictor of performance and success in different areas (career, academics, etc.). Grit is a trait-like factor defined as "perseverance and passion for long-term goals" (Duckworth, Peterson, Matthews, & Kelly, 2007 p. 1087). It is operationalized as two factors representing consistency of interest and perseverance of effort. Von Culin, Tsukayama, and Duckworth (2014) define consistency of interest as "abiding focused interests over time" (p. 308) and perseverance of effort as a "tendency toward a sustained effort" (p.308). A driver in this area of research has been to find a response to the question – "why do some individuals accomplish more than others" (Duckworth, et al. 2007, p. 1087). Previous studies have examined the role of intelligence and the Big Five personality traits in attempting to understand and answer this question (Credé, Tynan, & Harms, 2016). Grit has been shown to extend the explanatory capabilities of success and performance models beyond these traditional factors. It has also been shown as related specifically to retention (Duckworth & Quinn, 2009).

To begin our examination, the following section provides an overview of the grit literature. Special attention is given to the items that are examined in this study to provide a foundation on which to examine grit in information systems students.

2. LITERATURE REVIEW

Previous research related to understanding performance and success has often looked to personality traits as ways of understanding why individuals differ related to these types of outcomes (Siebert & Kraimer, 2001). Determining reasons why some people are more successful than others has driven a majority of educational and workforce research efforts.

From an education perspective, success is often measured by the progression of an individual through the required stages of an academic program; the final result of which is the completion of a degree. The examination of personality traits in relation to academic success has also shown a connection. In fact, "the contribution of personality traits to academic achievement may be as great as or greater than that of intelligence" (Willingham, 2016 p.30).

In an effort to expand what is understood regarding factors that impact individual success and performance, grit was operationalized as a unique construct representing an individual's perseverance and passion for long-term goals (Duckworth, et al. 2007). It is a concept that is closely, but distinctly, related to the trait of conscientiousness. While conscientiousness focuses on "short-term intensity" (Duckworth, et al. 2007 p. 1089), grit emphasizes the long-term by examining two subscales: consistency of interest and perseverance of effort. Research specifically related to conscientiousness has shown significant relationships with the trait and measures of success, including factors related to an individual's career (pay, promotion, satisfaction) (Thomas, Eby, Sorensen, & Feldman, 2005).

Since its introduction, grit has garnered much research attention. It has been related to GPA, success in national competitions, such as the National Spelling Bee, as well as other areas that require deliberate practice over a period of time (Credé, Tynan, & Harms, 2016; Willingham, 2016). Specifically, it has been shown that students with higher levels of grit outperform their peers with lower levels of grit evidenced by higher GPAs (Duckworth, et al. 2007).

Age has also been linked to grit in previous studies. In a study examining grit scores of over 1500 individuals (25 and over), it was found that older adults have higher levels of grit (Duckworth & Quinn, 2009). While the study did not, intentionally, include younger individuals, the impact of age was significant in this case, but when looking across the literature results are mixed (Credé, et al. 2016).

Gender has also been examined in numerous studies focused on understanding grit and other trait-like factors. Interestingly, across various samples, gender's relationship to grit has been weak and somewhat mixed (Credé, et al. 2016). In relation to other personality traits, men and women often differ significantly (Maestripieri, 2012). In examining the related construct of conscientiousness, for example, women often score higher than men on some aspects, but, again, the findings are mixed (Weisberg, DeYoung, & Hirsh, 2011).

An additional factor we are considering in this study relates to academic classification and where students are in their program of study. While this has not been specifically examined in relation to grit, previous research has found that "more educated adults were higher in grit than were less educated adults of equal age (Duckworth, et al., 2007 p. 1091).

The following section details the methodological approach taken in examining grit and the concepts just described for information systems students. General demographic information is summarized and detailed model analyses presented.

3. METHODOLOGY

To assess grit, the eight-item Short Grit Scale (Grit-S) was utilized (Duckworth & Quinn, 2009). In this short scale version, 4 items each are used to determine the individual's consistency of interest and perseverance of effort (Table 1). All items were measured on a 7-point Likert-type scale with 1 representing "Very untrue of me" and 7 representing "Very true of me". Consistency of interest was measured on a reversed scale, where higher values indicate more inconsistency. These scores were inverted prior to analysis for improved interpretability.

Additional information collected in the survey included demographic data on gender, age, employment, and year (academic classification) in school. Respondents were also requested to self-report their current overall GPA as well as their GPA in IS courses only. This data was collected in nine ordinal categories rather than as a raw value (Table 2).

Data was collected from students at a large public university in the southeastern United States. Surveys were distributed in graduate and undergraduate courses offered by the Department of Computer Information Systems housed in the university's college of business. The courses targeted were those required as part of the information systems degree programs.

A total of 196 students took part in the voluntary survey; this represents 54.3% of the students enrolled in the program at the time of the data collection. Although there was a possibility of students seeing the survey in multiple courses, they were requested to only take part once. From the 196 responses, nine were removed from the sample due to lack of significant completion or invariable responses (i.e. one response repeated throughout the questionnaire). Of the remaining 187 responses, 11 were subsequently removed due to incomplete responses to the eight grit items resulting in a sample consisting of 176 students.

A total of eight courses were surveyed in the study, with the level of the course noted as a proxy for how far a student has progressed in their academic program. Two courses were surveyed at the sophomore (60 responses) and junior level (32 responses), three at the senior level (67 responses), and one at the graduate level (17 responses). Descriptive statistics on demographic information, including academic classification, are shown in Table 2. From the confluence of course and academic position information, it was determined that approximately 57% of the respondents were in courses at a level consistent with their classification (e.g. a student in a junior level course was a junior by classification). Due to the utilization of information systems as a secondary "career saving" major, this was considered a potentially important distinction in determining how program progress relates to grit.

4. ANALYSIS

An initial confirmatory factor analysis was performed to determine the degree of fit of the pure grit construct to the population of information systems students. Determination of fit is based on the standard measures of the χ^2 statistic, the root mean square error of approximation (RMSEA; Steiger & Lind, 1980), the comparative fit index (CFI; Bentler, 1990), and the non-normed fit index (NNFI; Tucker & Lewis, 1973). According to Hu and Bentler (1999), a value of .06 or below is considered an acceptable fit based on the RMSEA, while the comparative values for the CFI and NNFI are .90 or more (with .95 or greater preferred). Analyses were performed utilizing R (R Core Team, 2013) and the lavaan package (Rosseel, 2012).

Based on a positive overall fit, the next step is to determine if any of the factors captured in the study are associated with the grit level of the respondents. Factors under consideration include the standard demographic variables like gender and age, along with employment status. We also extend the research to academic classification and the course in which the survey was performed. The analysis of these factors is performed via a series of measurement models with increasing restrictions on the components of the model that are allowed to vary in each group. Model 1, the baseline model, incorporates the groups into the model with no restriction other than equivalent factorial structure. A good fit of Model 1 would indicate configural invariance among the groups. Model 2, which includes the factor structure constraint from Model 1, adds the restriction that factor loadings are equivalent among the groups. The fit of Model 2 would indicate metric invariance and allows for the investigation of group differences in grit or its subscales. Model 3 adds a requirement for equal intercepts to the requirements of Model 2 and is an indication of scalar invariance. Model 4 requires the equivalence of error variances among the groups in addition to prior restrictions and is often referred to as strict invariance; it is not necessary to achieve proper fit in Model 4 in order to compare scores. In this analysis, Model 5 represents the equivalence of factor variance/covariance structures among the groups, and is incremental to the requirements of Model 4. Model 6, which is the final model in this analysis, considers whether factor means can be considered equal among the groups. It should be noted that this model will be tested as a marginal change from Model 4; Model 5 fit is not required.

As the results of each model are incremental, a determination can be made concerning the extent to which the grit construct differs among these groups (i.e. when the marginal change produces an ill-fitting model, then the prior model provides the extent to which the groups do not vary). In evaluating these models, the Akaike Information Criterion (AIC; Akaike, 1974) and McDonald's non-centrality index (NCI; McDonald, 1989) will also be used due to their applicability to nested models. For nested models, lower values of AIC generally indicate a better fit. Cheung and Rensvold (2002) recommend marginal changes in excess of -.01 and -.02 for the CFI and NCI measures respectively to move to a more restricted model. A good explanation of the process of testing measurement invariance can be found in Milfont and Fischer (2010).

Following the results of measurement invariance analysis, the relationship of the grit factor model to quantitative variables age, overall GPA, and major GPA are evaluated. Subsequently, composite scores are determined for each component of grit for each respondent. Those scores are subjected to the analyses of variance/covariance to determine the effect of variables that had a significant relationship to the individual subscales of grit.

Results

The internal consistency of the overall Grit-S scale as measured by Cronbach's Alpha was .71. Measures for the individual subscales of consistency of interest and perseverance of effort were .61 and .63 respectively. A maximum-likelihood confirmatory factor analysis was run on the sample on the first-order latent variable of consistency of interest and perseverance of effort loading on the second order latent grit factor. Indications of overall model fit were strong, with $\chi^2 = 19.62$ (19 *df*, $p = .418$), RMSEA = .014 (90% CI = .000-.068), CFI = .997, and NNFI = .995. All *p*-values of estimated parameters were less than .001. The observed correlation between subscales was .448. The ratio of observations per estimated parameter was greater than 9 to 1, sufficient based on the criterion of exceeding 5 to 1 from Bentler and Chou (1987).

The invariance of the grit factor model was evaluated as it related to the gender of the respondent. Models 1 through 6 were fitted with corresponding fit statistics shown in Table 3. Based on the results from Model 1, it can be concluded that the overall fit of the grit model to information systems students was acceptable when gender is brought in as a mitigating factor. The results show that increasing restrictions are not significantly detrimental to the model's fit. All models show acceptable fit levels and marginal changes to AIC, CFI, and NCI are within acceptable values at all increments. Given these results, it can be concluded that gender plays no role in the measurement of grit in this population.

The structure of the grit factor model relative to the self-identified employment groups on the survey was evaluated next. The baseline model with the inclusion of the employment factor indicated strong fit (Table 4). Subsequent nested models indicated a noticeable degradation of fit from Model 3 (scalar invariance) to Model 4 (strict invariance), signifying a difference in residual error in the groups. These findings show that there is sufficient basis to evaluate mean composite grit scores among employment groups in a follow-up analysis.

The evaluation of the grit factor model to the position in program (i.e. level of course in which the measurement was made) and academic classification (i.e. Sophomore, Junior, Senior) was not possible due to non-convergence of confirmatory factor analyses when these groups where separately analyzed. This is likely due to relatively small sample sizes in certain groups (e.g. 17 observations in the 6000 level course and 15 observations at the sophomore level). Convergence was achieved by imposing parameter restrictions on the model, but this was considered to be too assumptive to allow for conclusive analysis.

To evaluate the effect of age on the measurement of grit, the model used in the initial confirmatory factor analysis was modified to include age as a covariate to both subscales. Model fit was acceptable but had degraded from the initial model: $\chi^2 = 35.613$ (25 *df*, $p = .078$); RMSEA = .050 (90% CI = .000-.084); CFI = .949; NNFI = .926. The *p*-values of all estimated parameters were at or less than .002 except for the parameter estimates for age for both subscales. The *p*-value for the age coefficient for consistency of interest was .052 and for perseverance of effort was .804. As the effect of age may have been carried through the correlation of the two subscales, it was decided to drop the least significant relationship of age to perseverance of effort. The subsequent model showed marginally better fit: $\chi^2 = 35.671$ (26 *df*, $p = .098$); RMSEA = .047 (90% CI = .000-.081); CFI = .953; NNFI = .935. Importantly, all parameter estimates had *p*-values at or less than .002 including the parameter for the relationship of age to consistency of interest.

Numerical estimates were determined for the overall and within major GPAs utilizing the midpoint of each GPA category in the survey. These variables were included in the initial grit model under both of the grit subscales. The fit of this All GPA model was marginally within the acceptable range (Table 5). All parameters relating each GPA to each subscale were insignificant (*p*'s > .138). Removing insignificant parameters sequentially led to a Reduced Model where both GPAs were only related to consistency of interest ($p < .001$). However, the fit of the overall grit model had degraded significantly such that the model no longer fit acceptably. Interestingly, the problem appeared to be related to redundant information being passed along these GPA variables. Individuals with high overall GPA were also probably the individuals with high within-major GPA. From this analysis, the best model included overall GPA to consistency of interest (Table 5).

As a follow-up to the results of the measurement invariance analysis and covariates, composite scores for the individual subscales of grit were calculated to provide additional insight into their relationship with employment status and age. Separate ANOVAs were performed on each of the subscales to determine the significance and direction of employment effects.

At least one difference was significant among the mean consistency of interest composite scores for the different levels of employment status ($p = .0030$). Using Tukey's honest significant difference test (HSD) for pairwise comparisons, it was determined that students who are employed full-time had a mean composite score .349 higher (95% CI: .051-.646) than part-time employed students, and a mean composite score .458 (95% CI: .124-.791) higher than students who were not employed. The difference between part-time and non-employed students was not significant.

For the perseverance of effort subscale, there was at least one significant difference in the mean composite score among the employment levels ($p = .0073$). As with the other subscale, Tukey's HSD found differences between full-time and part-time employed students (d = .277; 95% CI: .010-.545) and full-time and non-employed students (d = .384; 95% CI: .084-.684); the mean scores of part-time and non-employed students were not significantly different. Assumptions of the ANOVA were again reasonable based on an analysis of the residuals.

Findings indicated that age was related to the measure of grit. There is also reason to believe that age and employment might be correlated. An ANCOVA was performed to analyze mean composite grit scores for differences among levels of employment status after taking into account the age of the respondent. For consistency of interest, both employment status ($p = .0275$) and age ($p = .0165$) were significantly related to the mean composite score. Interestingly, the inclusion of age did not sufficiently reduce the unexplained error of the model enough to make any major changes to the results from Tukey's HSD. The 95% confidence intervals for the differences between full-time/part-time and full-time/non-employed were very close to the results without age taken into account. On the perseverance of effort subscale, the results of the ANCOVA showed age did not have a significant effect ($p = .062$) on the mean composite score. Assumptions appeared to be reasonable under both tests.

5. DISCUSSION

In this examination of grit, the focus was specifically on information systems students and the relationship of grit with key demographic variables. Findings revealed some consistencies and differences when compared to previous research on the trait.

In alignment with existing findings, gender did not impact the grit model (Duckworth & Quinn, 2009). For this group, males and females see grit the same. While the sample consisted of a majority of male students (77%), it was generally representative of the profession where females account for approximately 25% of all computer-related occupations (Ashcraft, McLain, & Eger, 2016). The sample was also representative of the student body comprising the information systems program (Table 2). The findings imply that grit does not vary across gender and that men and women have the same level of grit. With the long-term focus on grit, it seems that men and women are not distinct in their levels of enduring interests and the level of effort they sustain.

In examining grit and adding age to the model, we found age was related more to consistency of interest than perseverance of effort. Age has been found to be significantly related to grit in previous studies (Duckworth and Quinn, 2009) but has been shown in other cases to have only a slight correlation with the overall grit measure (Credé, et al., 2016). As findings across studies reveal somewhat different relationships, further examination is warranted. The examination of age as related to the sub-scales of grit may provide more information on the importance of considering age of the individual in understanding this trait. This could involve looking at other academic disciplines and providing the opportunity to compare across groups; it could also involve extending the examination to include individuals that work in the IS profession.

When examining grit with the addition of the GPA items in the model, findings revealed that GPA was more related to consistency of interest for this group of information system students, while the overall grit measure was found to be related to GPA in a previous study (Duckworth, et al., 2007). More recently, perseverance of effort was found to be a "superior predictor of GPA" (Duckworth & Quinn, 2009), which is counter to our findings. It appears that, in this case, information systems students do differ from other populations.

The findings also indicate that information systems as an academic discipline is tightly aligned with practice. For this group of students, grit was associated with employment, with students employed full-time having the highest levels of grit when compared to their counterparts. Previous research has noted that some of the matters often attributed with individuals not completing academic programs relates to financial and work-life balance issues (Lee & Stewart, 2016). This finding indicates that there may be an associated level of grit and the ability to successfully manage multiple responsibilities.

As a final point of discussion, it is necessary to consider the implications of the findings and what it means for those in higher education and practice. Part of the discussion of grit, as well as other personality-related traits, surrounds the ability to teach or alter grit. For example, if a certain level of grit is associated with success in a particular area, whether it is in an academic program or in a job or career, is it possible to alter "grittiness"? (Willingham, 2016). Answering this question is beyond the scope of the current study, but it does warrant consideration when examining the construct and the purpose of understanding it.

6. LIMITATIONS AND FUTURE RESEARCH

It is necessary to address the limitations of the current study and paths for improving and expanding research in this area. One limitation involves the use of a cross-sectional study design. It would be beneficial to collect data at multiple points in time during an individual's progression through an academic program. An example could be to collect data upon entry into the university and program followed by each milestone achieved as the student moves from being a freshman to sophomore, etc. The collection of data longitudinally would assist in understanding the role of grit's impact on success and whether there are shifts in individual levels of grit.

Additionally, the data was collected from students at one university, which could limit generalizability of the findings. Outcomes have been shown to differ across institution types. For example, the National Center for Education Statistics indicates that the graduation rate for public universities is 58% compared to private non-profit schools at 65% over the same six-year time period (Lee & Stewart, 2016). Expanding the research to include individuals at other institutions as well as different types (public and private universities) would provide additional support and detail in understanding grit in students in information systems programs.

Another issue presented in this analysis involved the self-reporting of GPA. Since no identifying information was collected, it was not possible to connect official GPA information to the individual participants. In an effort to better understand the implications for the current study, the researchers obtained general information on all information systems majors and compared the results to what was reported by the participants. As provided in Table 2, there were differences. Future research should aim at collecting official GPAs to further understand the results from this initial analysis.

The findings of this study indicated that individuals with full-time jobs had higher levels of grit when compared to individuals in part-time positions or those that stated they were unemployed. Extending research around factors related to work situations and other work-life factors could provide additional insight and help answer questions such as, do gritty full-time employees go after a degree to improve themselves or do gritty students try to take on responsibilities beyond education? Interesting factors to consider would include number of children, marital status, income level, and whether or not the individual is the first in their family to attend college. It could also prove important to know whether the individuals that were employed were in an information systems role or a job unrelated to the field. If individuals are employed in information systems, it would stand to reason that their career decisions are driven not only by extrinsic items such as pay but by their intrinsic motivations to be a part of the IS profession.

As a final recommendation for future research, it seems necessary to examine the role that grit plays in determining key outcomes for not only information systems students but for students in other disciplines. The findings of this initial study provided interesting results that did not align with previous research examining grit. Determining whether grit differs for students in different majors could provide insight into the types of students that are drawn to certain areas and whether or not the students are likely to succeed. Knowing more about traits associated with the individuals that comprise different disciplines could also assist in advising, increasing enrollment, and defining program components that adequately and appropriately align with student characteristics.

7. CONCLUSION

In summary, this study examined grit for information systems students and investigated the impact of certain demographic variables on overall grit and the subscales of perseverance of effort and consistency of interest. After running multiple analyses, findings revealed that employment status and grit are related, which had not previously been examined. Additionally, the data collected from information systems students exposed relationships that were not completely consistent with existing research. These findings warrant the continued examination of the concept of grit giving consideration to the discipline. Results also highlight the need for further examination of employment-related factors for information systems students.

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Appendix

Table 1: Grit Items

Item	Subscale	Statement
1	CI	I often set a goal but later choose to pursue a different one.
2	CI	New ideas and projects sometimes distract me from previous ones.
3	CI	I have been obsessed with a certain idea or project for a short time but later lost interest.
4	CI	I have difficulty maintaining my focus on projects that take more than a few months to complete.
5	PE	I finish whatever I begin.
6	PE	Setbacks do not discourage me.
7	PE	I am a hard worker.
8	PE	I am diligent.

Note: CI=Consistency of Interest; PE=Perseverance of Effort

Table 2: Demographics

Variable	Sample	Sample Percent	Percent in Program
Year			
Freshman	0	0.0%	0.3%
Sophomore	15	8.6%	8.3%
Junior	42	24.0%	18.0%
Senior	82	46.9%	46.3%
Graduate	36	20.6%	27.1%
Gender			
Male	137	77.8%	78.7%
Female	39	22.2%	21.3%
GPA overall			
Below 2.00	0	0.0%	0.8%
2.00-2.24	2	1.1%	3.9%
2.25-2.49	6	3.4%	6.1%
2.50-2.74	18	10.3%	10.0%
2.75-2.99	18	10.3%	10.2%
3.00-3.24	32	18.4%	16.3%
3.25-3.49	29	16.7%	17.2%
3.50-3.74	27	15.5%	15.2%
3.75-4.00	42	24.1%	20.2%
GPA within major			
Below 2.00	1	0.6%	3.9%
2.00-2.24	0	0.0%	1.1%
2.25-2.49	5	2.9%	3.6%
2.50-2.74	9	5.2%	5.8%
2.75-2.99	5	2.9%	5.0%
3.00-3.24	33	19.0%	10.8%

3.25-3.49	28	16.1%	14.7%
3.50-3.74	22	12.6%	19.4%
3.75-4.00	71	40.8%	35.7%
Employment			
Full-time	52	29.5%	
Part-time	77	43.8%	
Age			
19-21	42	24.4%	
22-24	48	27.9%	
25-27	27	15.7%	
28-30	25	14.5%	
31-33	8	4.7%	
34-36	8	4.7%	
37-39	6	3.5%	
40-42	2	1.2%	
43-45	0	0.0%	
46-48	3	1.7%	
49 or more	3	1.7%	

Table 3: Goodness of Fit Statistics for Model Testing

Measurement Invariance across Gender

Model	χ^2	*df*	p-value	RMSEA	AIC	CFI	NCI	NNFI
1	48.46	38	0.119	0.056	4860.4	0.949	0.971	0.925
2	55.88	44	0.108	0.055	4855.9	0.942	0.967	0.927
3	63.00	50	0.103	0.054	4851.0	0.937	0.964	0.929
4	72.10	58	0.101	0.053	4844.1	0.932	0.961	0.934
5	73.57	61	0.130	0.048	4839.5	0.939	0.965	0.944
6	73.91	60	0.107	0.051	4841.9	0.933	0.961	0.937

Comparison of Nested Models

Models	$\Delta\chi^2$	Δ*df*	p-value	Δ RMSEA	Δ AIC	Δ CFI	Δ NCI	Δ NNFI
1 to 2	7.42	6	0.284	-0.001	-4.6	-0.007	-0.004	0.001
2 to 3	7.12	6	0.310	-0.001	-4.9	-0.006	-0.003	0.003
3 to 4	9.10	8	0.334	-0.002	-6.9	-0.005	-0.003	0.005
4 to 5	1.47	3	0.689	-0.004	-4.5	0.007	0.004	0.010
4 to 6	1.81	2	0.405	-0.001	-2.2	0.001	-0.004	0.003

Note: RMSEA = root mean square error of approximation; AIC = Akaike Information Criterion; CFI = comparative fit index; NCI = McDonald's non-centrality index; NNFI = non-normed fit index. Model 1 = equality of overall structure; Model 2 = Model 1 plus invariant loadings; Model 3 = Model 2 plus equivalent intercepts; Model 4 = Model 3 plus invariant residuals; Model 5 = Model 4 plus invariant covariance matrices; Model 6 = Model 4 plus invariance means.

Table 4: Goodness of Fit Statistics for Model Testing

Measurement Invariance across Employment Status

Model	χ^2	*df*	p-value	RMSEA	AIC	CFI	NCI	NNFI
1	52.15	57	0.657	0.000	4849.7	1.000	1.000	1.036
2	64.72	69	0.624	0.000	4838.3	1.000	1.000	1.027
3	77.82	81	0.580	0.000	4827.4	1.000	1.000	1.017
4	113.50	97	0.121	0.054	4831.0	0.916	0.954	0.927
5	127.69	103	0.050	0.064	4833.2	0.874	0.932	0.897
6	127.88	101	0.037	0.067	4837.4	0.863	0.926	0.886

Comparison of Nested Models

Models	$\Delta\chi^2$	Δ*df*	p-value	Δ RMSEA	Δ AIC	Δ CFI	Δ NCI	Δ NNFI
1 to 2	12.57	12	0.401	0.000	-11.4	0.000	0.000	-0.010
2 to 3	13.10	12	0.362	0.000	-10.9	0.000	0.000	-0.010
3 to 4	35.68	16	0.003	0.054	3.7	-0.084	-0.046	-0.090
4 to 5	14.19	6	0.028	0.010	2.2	-0.042	-0.022	-0.030
4 to 6	14.38	4	0.006	0.014	6.4	-0.053	-0.006	-0.041

Note: RMSEA = root mean square error of approximation; AIC = Akaike Information Criterion; CFI = comparative fit index; NCI = McDonald's non-centrality index; NNFI = non-normed fit index. Model 1 = equality of overall structure; Model 2 = Model 1 plus invariant loadings; Model 3 = Model 2 plus equivalent intercepts; Model 4 = Model 3 plus invariant residuals; Model 5 = Model 4 plus invariant covariance matrices; Model 6 = Model 4 plus invariance means.

Table 5: Goodness of Fit Statistics for Models Testing

Overall and Within Major GPA in Grit Models

Model	χ^2	*df*	p-value	RMSEA	CFI	NNFI
All GPA	52.85	32	0.012	0.061	0.935	0.908
Reduced Model	136.27	34	0.000	0.131	0.679	0.575
Overall GPA with CI	28.58	26	0.318	0.025	0.986	0.981
Major GPA with CI	21.58	26	0.712	0.000	1.000	1.031

Note: RMSEA = root mean square error of approximation; CFI = comparative fit index; NNFI = non-normed fit index. CI = Consistency of Interest. All GPA model = overall GPA and major GPA related to both subscales; Reduced Model = overall GPA and major GPA related to Consistency of Interest; Overall GPA with CI = overall GPA related to Consistency of Interest; Major GPA with CI = major GPA related to Consistency of Interest.