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Development and Validation of the Comprehensive Measure of Academic Success (CMAS) for School Students: A Construct Validation Approach

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Author Note

To develop the Comprehensive Measure of Academic Success (CMAS), pre-existing, reliable, and valid scales were carefully selected, adapted, and combined to form a multidimensional assessment tool. Modifications were made to ensure the scales were suitable for the target population. This approach resulted in a more holistic measurement tool of academic success.

Overview and Measurement Challenge

Promoting academic success among school and college students is one of the primary goals of educators, parents, and other stakeholders due to its significant impact on positive psychoeducational and career-related outcomes (Datu & Buenconsejo, 2021; Seligman et al., 2009). One challenge in studying academic success is defining and measuring the construct itself. Researchers have employed different indicators and measures to assess academic success. These include standardized test scores, critical thinking, and completion of educational milestones, with grades or grade point average (GPA) being the primary measure (York et al., 2015).

While grades provide valuable insights into the academic performance, relying solely on them to define and measure academic success may lead to an incomplete understanding of students' overall educational experiences and outcomes. Grades may not accurately capture actual learning, because they reflect a narrow focus on performance in examinations rather than broader understanding or critical thinking skills. Additionally, non-academic aspects of learning, such as social, emotional, and practical skills, are often overlooked when grades are the primary metric. Moreover, the varying difficulty of assessments between schools further complicates the validity of grades as a measure of academic success. This issue is pronounced in India, where differences in syllabi, curricula, and assessment criteria among educational boards and their affiliated schools further highlight the limitations of relying only on grades (Gupta, 2022). These limitations raise concerns about the adequacy of using grades as an academic measure in capturing the full spectrum of student success.

To address these limitations, researchers have highlighted the multidimensional nature of academic success (Kuh et al., 2006; York et al., 2015). Drawing and building upon the definition of academic success by Kuh et al. (2006) and further revision by York et al. (2015), the present study views academic success as a multidimensional construct. We define academic success as students' perception of *"attainment of learning objectives, acquisition of desired skills and competencies, satisfaction, persistence, and post-school performance"*, (adapted from York *et al.*, 2015, p5). This multidimensional approach may capture elements that grades alone can-not, such as students' acquisition of practical skills, their persistence through challenges, satisfaction with their educational experiences, and their performance beyond school, all of which contribute to a more comprehensive understanding of student success.

The present study aims to capture these dimensions of academic success by developing the Comprehensive Measure of Academic Success (CMAS), which re-flects a broader range of student achievements beyond grades, and by assessing its construct validity among school students. A construct validation approach pro-posed by Martin (2007) was adopted to assess the va-lidity of CMAS. Construct validation involves testing the within-network validity and between-network validity of the construct (Martin & Marsh, 2008). Within-network validity assesses the factor structure, measurement invariance, and internal consistency of the construct (here, CMAS). Between-network validity evaluates the construct being validated and its relationship with theoretically related construct.

In the present study, the factor structure of the CMAS, its internal consistency, and measurement invariance across gender were tested to assess the within-network construct validity. Further, the relationship between the dimensions of the CMAS and well-being was tested to assess the between-network construct validity because previous studies indicate a positive relationship be-tween academic success and well-being among school students (Cárdenas et al., 2022; Holzer et al., 2022).

Method

The following steps were taken to develop and test the

I. Selection of Scales

Following York et al. (2015), five existing, reliable, and valid survey measures were identified and selected from

the literature to assess the dimensions of academic success i.e., attainment of learning objectives, acquisition of desired skills and competencies, satisfaction, persistence, and post-school performance. Since some of the scales were originally designed for college students, certain words and phrases were adapted to ensure they were suitable and relevant for school students.

1. **Attainment of Learning Objectives** was measured using the 7 items from Academic self-efficacy developed by Chemers et al. (2001). A sample item is *'I know how to study to perform well on tests.'*

2. **Acquisition of Desired Skills and Competencies** was measured using the 6-item Generic Skills Scale, which is a sub-scale of the Course Experience Questionnaire (Curtis & Keeves, 2000). Participants were prompted with the phrase *'the courses taught in school'* and asked to rate items such as *'developed my problem-solving skills.'*

3. **Satisfaction** was measured using the 7-item Student Satisfaction Scale (Lounsbury et al., 2005). Participants were prompted with the phrase '*Please indicate your satisfaction or dissatisfaction in terms of…*' and asked to rate items such as *'the quality of teachers you've in your school.'*

4. **Persistence** was measured using the 4-item perseverance sub-scale of the EPOCH inventory (Kern et al., 2016). A sample item includes is *'I keep at my schoolwork until I am done with it.'*

5. **Post-school Performance** was measured using the three items from the belief in personal ability scale by Gaumer and Noonan (2018) and two items from Collaco's (2018) college success scale. These items reflected individuals' confidence in their ability to succeed in future endeavours. A sample item is *'I will succeed in whatever career path I choose.'*

II. Preparation of Items

All items were translated into Hindi following the guidelines in Sousa and Rojjanasrirat (2011). Two independent translators first translated the surveys into Hindi. The author then synthesized the translations to resolve any ambiguities, with input from both translators. An independent translator back-translated the synthesized versions into English. Two experts with over 10 years of teaching experience in Psychology at the post-graduate level compared the back-translated versions with the original versions to resolve any remaining discrepancies. The translated version of the scales was evaluated by 18 school students (Girls = 11, Boys = 7; M_{age} = 15.77; SD = 0.87; Range = 14-18 years) on item clarity through an online pilot study. Except for five items, all items were evaluated as clear. Based on their feedback, these five items were revised. The adapted scales were then integrated into a comprehensive survey to develop the CMAS, which included a total of 29 items.

III. Survey Administration

The participants were 310 school students (Boys = 163; M_{age} = 16.08; SD = 0.701; Range = 14-18 Years: Girls = 147; M_{age} = 16.09; SD = 0.592; Range = 15-17 Years) from 11th grade. They were recruited from three government schools in Kanpur district using convenience sampling approach. All three schools were affiliated with the Central Board of Secondary Education (CBSE). These students were sampled from the disciplines of Science (N = 225), Commerce (N = 54), and Humanities (N = 31). A questionnaire containing the CMAS along with the Hindi version of the Brief Inventory of Thriving (BIT; Su et al., 2014) was administered in their classrooms during zero period following approval from the school principals. BIT was used specifically to assess their well-being scores on a 5-point scale (1 = Strongly Disagree; 5 = Strongly Agree). For the CMAS, responses were recorded on a 7-point scale, where 1 indicated *Strongly Disagree/Very Dissatisfied* and 7 indicated *Strongly Agree/Very Satisfied*.

Prior to survey administration, ethical approval from the author's affiliated institution and active consent forms from participants were obtained. Participation in the study was voluntary and no compensation was offered.

Data Analysis

1. Ancillary Data Analysis

Before testing the construct validity of the CMAS, the data were screened for missing values and normality assumptions. Missing values in the data were less than one percent. Little's test revealed that the data was

missing completely at random (MCAR) as indicated by χ^2 (817) = 838.537, p = .293. Therefore, the missing values were imputed by the median values on the scale. The skewness and kurtosis values of all the items were below ±2 and ±7, indicating univariate normality (Finney & DiStefano, 2006). However, Mardia's multivariate kurtosis value was above 5, which indicated a violation of the multivariate normality (Byrne, 2010).

2. Within-network Construct Validity

Within-network validity was assessed by testing the factor structure, measurement invariance (MI) across genders, and internal consistency reliability. Confirmatory factor analysis (CFA) was used to test the factor structure, i.e., how well the CMAS captures the five stated dimensions of academic success. Three models were tested and compared: (1) a unidimensional model (which assumes all items measure a single con-cept), (2) a five-dimensional model (which assumes items measure five distinct but related concepts), and (3) a second-order five-dimensional model (which includes a higher-level factor influencing the five factors). Given the violation of multivariate normality in the data, models were evaluated using Maximum Likelihood Estimation with Robust Standard Errors (MLM). Apart from the non-significant p-value of the χ^2 statistic, four commonly used model fit indices were assessed to evaluate model fit: Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI), where values ≥ .90 suggest an acceptable fit and ≥ .95 suggest an excellent fit; Root Mean Square Error of Approximation (RMSEA), with its 90% confidence interval, and Standardized Root Mean Squared Residuals (SRMR), with values ≤ .08 indicating reasonable fit and ≤ .05 indicating close fit (Lance et al., 2006). Further, the MI was tested across participants' gender at three levels: configural (to test whether the factor structure was similar across both groups), metric (to test whether item loadings were equivalent across both groups), and scalar (to test whether item intercepts were similar across both groups). To test MI, the factor structure, item loadings, and item intercepts were sequentially constrained to test the MI at the configural, metric, and scalar levels, respectively using multi-group confirmatory factor analysis (MGCFA). Changes in ΔCFI and ΔRMSEA below .01 and .015, respectively, served as an indication of MI (Cheung & Rensvold, 2002). McDonald's Omega (ω) coefficient value ≥ .70 was considered a good indicator of reliability.

3. Between-network Construct Validity

Between-network construct validity was examined to test how well the dimensions of CMAS relate to students' well-being using Pearson's product-moment correlation coefficient (r). The r values of .10, .20, and .30 indicate small, medium, and large correlations, respectively (Gignac & Szodorai, 2016). The missing values were analysed using IBM SPSS. CFA and MG-CFA were conducted on R studio using *lavaan* (Rosseel, 2012) and *ccpsyc* (Fischer & Karl, 2019) packages, respectively. Item level statistics, McDonald's Omega, and Pearson's product-moment correlations were analysed using JASP.

Results and Discussion

CFA results demonstrated that both the five-dimensional and second-order five-factor models of CMAS were an acceptable fit to the data (Table 1). Table 1 also suggests that the unidimensional model of CMAS resulted in a poor model fit,

Table 1: Model fit Indices of the Comprehensive Measure of Academic Success

Models	S-Bχ^2 (*df*)	p	S-Bχ^2/*df*	CFI_{scaled}	TLI_{scaled}	$RMSEA_{scaled}$ [90% CI]	SRMR
1. Unidimensional Model	1163.86 (377)	<.001	3.09	0.719	0.698	0.082 [0.078-0.086]	0.086
2. Five-Dimensional Model	517.365 (362)	<.001	1.43	0.945	0.938	0.037 [0.031-0.043]	0.055
3. Second-Order Model	547.840 (371)	<.001	1.47	0.937	0.931	0.039 [0.034-0.045]	0.071

Note: S-Bχ^2 = Satorra-Bentler Chi-Square; *df* = degree of freedom; CFI_{scaled} = robust comparative fit index; TLI_{scaled} = robust Tucker-Lewis index; $RMSEA_{scaled}$ = robust root-mean-square error of approximation; CI = confidence interval; SRMR = standardized root-mean-square residual.

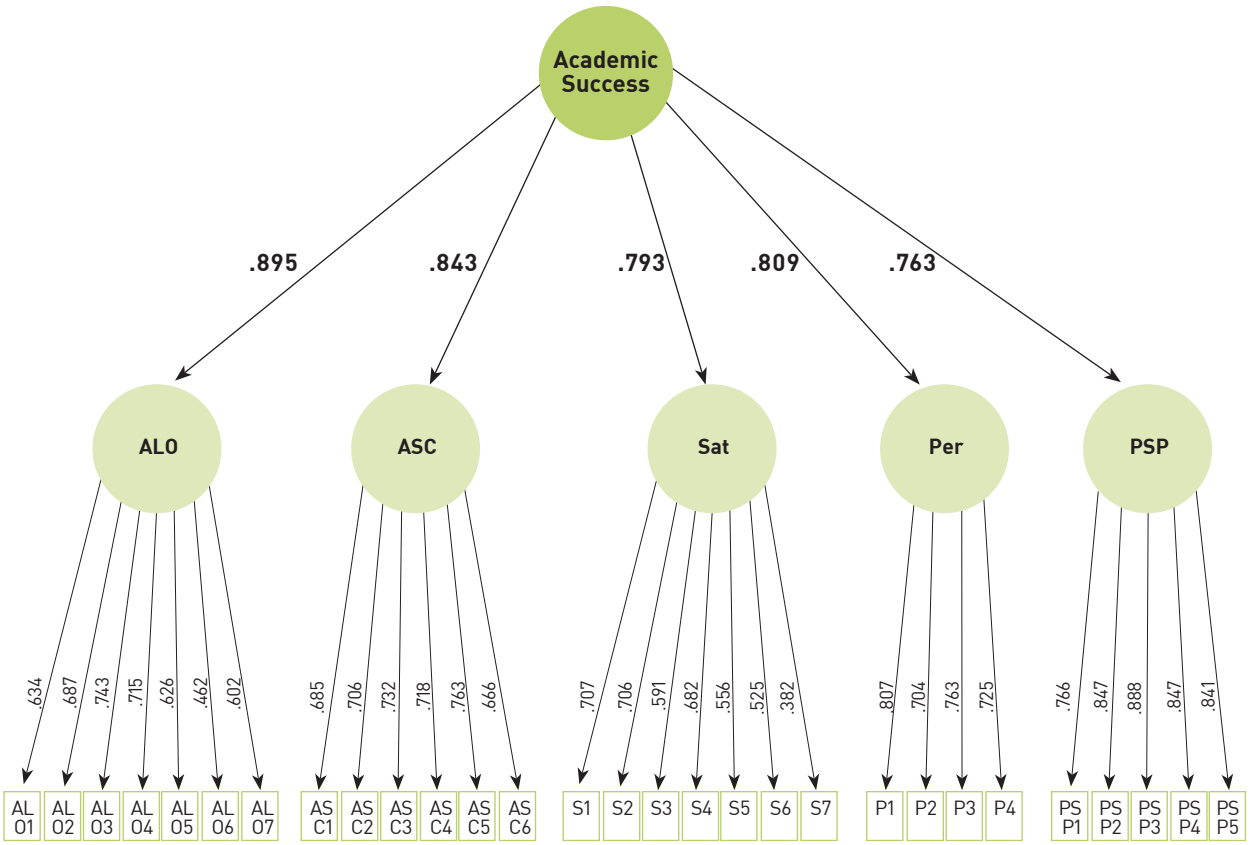
further validating the multidimen-sional nature of academic success. Figure 1 indicates that the items' factor loadings were significant for their respective factors (0.382 to 0.888, $p < .001$) and for the second-order factor of academic success (0.763 to 0.895, $p < .001$). Table 2 shows the results of MI test between the boys and girls. The changes in the CFI and RMSEA across the three levels of invariance were lower than .01, which indicates that the scalar invariance was achieved. This means that the CMAS functions consistently across both groups, with each item having the same meaning and equivalent levels

Table 2: Measurement Invariance of the Comprehensive Measure of Academic Success across Genders

Models	S-Bχ^2 (*df*)	*p*	S-Bχ^2/*df*	CFI_{scaled}	TLI_{scaled}	$RMSEA_{scaled}$ [90% CI]	SRMR	Models Comparison	ΔCFI_{scaled}	$\Delta RMSEA_{scaled}$
1. Configural	990.45 (724)	<.001	1.37	0.911	0.901	0.049 [0.042 – 0.055]	0.07	-	-	-
2. Metric	1019.34 (748)	<.001	1.36	0.91	0.902	0.048 [0.042 – 0.054]	0.08	1 and 2	0.001	0.001
3. Scalar	1062.90 (771)	<.001	1.38	0.903	0.898	0.049 [0.043 – 0.055]	0.081	2 and 3	0.007	0.001

Note: S-Bχ^2 = Satorra-Bentler Chi-Square; *df* = degree of freedom; CFI_{scaled} = robust comparative fit index; TLI_{scaled} = robust Tucker-Lewis index; $RMSEA_{scaled}$ = robust root-mean-square error of approximation; CI = confidence interval; SRMR = standardized root-mean-square residual; Δ = difference.

Figure 1: A Second-Order Five-Dimensional Model of CMAS



Note: ALO = Attainment of Learning Objectives; ASC = Acquisition of Desired Skills and Competencies; Sat = Satisfaction; Per = Persistence; PSP = Post-School Performance

Table 3: Descriptive Statistics and Correlation Coefficients among the Dimensions of the Comprehensive Measure of Academic Success and Well-Being

	M	*SD*	1	2	3	4	5	6
Attainment of Learning Objectives	38.5	7.17	0.83					
Acquisition of Desired Skills and Competencies	32.1	7.1	.671***	0.868				
Satisfaction	43.17	7.62	.620***	.633***	0.786			
Persistence	21.88	4.65	.649***	.593***	.456***	0.835		
Post-School Performance	29.72	6.15	.599***	.488***	.465***	.541***	0.916	
Well-Being	39.29	6.48	.538***	.447***	.628***	.448***	.441***	0.826

Note: Values along the diagonals reflect internal consistency reliability as measured by McDonald's Omega.
*p < .05; **p <. 01; ***p < .001.

for both boys and girls. All the dimensions of CMAS had a good internal consistency reliability (see Table 3). Table 3 also demonstrated a significantly high correlation between the dimensions of academic success and well-being, indicating the between-network validity of CMAS and aligning with previous studies (Cárdenas et al., 2022; Holzer et al., 2022).

The present study contributes to the academic success literature by developing a multidimensional measure of academic success and testing its psychometric properties using a construct validation approach among school students. By incorporating multiple dimensions beyond traditional GPA metrics, the CMAS provides a holistic view of students' academic experiences and outcomes. While the present study provides preliminary evidence for the within-network and between-network construct validity of the CMAS, several limitations must be noted. First, the present study did not test the convergent validity and criterion validity of the CMAS. Future research may address this by including other multidimensional measures of academic success and by predicting students' grades. Second, the study focused on a specific sample of school students in India, which may limit the generalizability of the findings to other cultural or educational contexts. Future studies may include a more diverse sample to enhance the applicability of the CMAS. Third, the cross-sectional design of this study limits the ability to draw causal inferences regarding the relationship between academic success and well-being. Longitudinal studies may be helpful in establishing causal links between academic success and well-being. Additionally, the study relied on self-report measures, which may introduce biases such as social desirability and response biases. Incorporating multiple data sources, such as teacher evaluations and objective academic records, may provide additional insights into academic success. While the CMAS includes several important dimensions of academic success, it may not capture all relevant aspects, such as involvement in extracurricular activities. Future research may consider expanding the measure to include these dimensions. Finally, the CMAS was developed and validated within the Indian context, and its applicability in other cultural settings remains to be tested. Cross-cultural validation studies are necessary to confirm its relevance and reliability in different cultural contexts. Despite these limitations, the CMAS represents a valuable step forward in capturing the complex and multifaceted nature of academic success, providing educators, researchers, and policymakers with a more comprehensive tool for fostering and evaluating student's academic success.

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1. To pilot innovative data collection methods and mainstream successful pilots into larger data collection efforts;
2. To impart formal and informal training to a new generation of data scientists; and
3. To serve as a resource for data stakeholders, including Government data agencies and ministries.

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