Examining the Structural Validity of the CD-RISC among Engineering Students

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Abstract

This work in progress study examines the structural validation of the Connor-Davidson Resilience Scale (CD-RISC). Resilience, an ability to respond positively to challenging situations, is an essential psychological attribute in responding to stressors. Students often encounter stressful situations that could influence their motivation to remain and succeed in an engineering degree. Developing and strengthening resiliency among engineering students is essential for their academic success in engineering. Participants included 150 undergraduate students enrolled in a foundational engineering course who completed an online survey of the resilience measure. A confirmatory factor analysis was performed to examine the structural validity evidence of the CD-RISC. Model fitness statistics based on CFI, TLI, RMSEA indicated that a five-factor model of the CD-RISC is acceptable. Convergent validity and discriminant evidence were examined using the AVE and MSV estimates. The analysis indicated some concerns with the validity evidence of the instrument. Implications of findings and future directions are discussed.

Introduction

Stress and adversities are common experiences of everyday life. Students encounter stressful factors that challenge their motivation to pursue and persist in academic goals. Such factors often require being resilient in the face of academic adversities. The ability to navigate risk factors, recover from academic setbacks, and adapt to stress or adversity is described in the literature as resilience. Broadly defined, resilience is the ability to "bounce back" from adversity or stressful situations to achieve the desired goal [1-3]. Resilient students are better equipped to navigate difficult situations, adapt to changes, recover from setbacks, and maintain high levels of academic motivation despite the academic stresses they encounter [4].

The students of certain disciplines (e.g., nursing and engineering career) are more susceptible to encountering very high levels of academic stress that daunts their resolution to persist in degree programs [5, 6]. Such academic stress may be due to the demanding nature of the learning tasks that students are required to complete within such disciplines. For example, some first-year engineering students need the ability to negotiate and overcome the initial setbacks they encounter in foundational engineering courses if they hope to endure and complete their undergraduate degree programs. Despite the importance of resilience in academic environments [7] and engineering [8, 9], there has been relatively little research focusing on resilience and its implications in engineering education.

Measures of Academic Resilience

Being able to reliably and validly measure resilience is vital for engineering education research and practice. Several studies have examined the measurement properties of different resilience instruments across different contexts [10-12]. Researchers have identified different resilience measures. A systematic review of resilience measures by Windle, et al. [13] reveals that resilience and resilience measures have scarcely been examined within engineering contexts. This undermines the generalizability of extant resilience measures for application within engineering contexts [14]. For example, we adopted the Connor-Davidson Resilience Scale (CD-RISC) to measure resilience in a student resilience project that we have embarked upon. Although the instrument is a highly studied and cited resilience measure, we found no empirical study that documents the validity of its use with engineering students.

The CD-RISC is a 25-item resilience instrument that measures the resilience construct and its cognates. Although the literature identifies the CD-RISC as a reliable measure, efforts to replicate the factorial structure in different samples have not been successful [15, 16]. Because resilience scores are evaluated under different risk conditions and ethnic settings, the interpretation of factors could be construed differently among various populations. Further, the operationalization of resilience constructs varies across different contexts [17]. However, research success and assessment of engineering student resiliency will depend on the availability of valid and reliable resilience measures.

This current study examines the structural validation of the CD-RISC among students enrolled in an engineering college. The study seeks to examine the validity of the scale to facilitate resilience research in engineering education contexts. We examined validity support for the CD-RISC by using confirmatory factor analysis to analyze the responses of a sample of engineering students. We further examined the reliability of factors on the scale.

Methods

Participants

The participants were 150 undergraduate students (74% male, 26% female) enrolled in a foundational engineering course at a large Southeastern university in the United States of America. Participants in the class completed a resilience survey administered online. The survey asked them to respond to how they typically respond to adverse circumstances. Most of the students self-identified as Caucasians (72%). All students responded to the online survey and received additional class credit upon completion.

Measures

The Connor-Davidson Resilience Scale- CD-RISC: The CD-RISC is a 25-item resilience measure that assesses the ability to bounce back from adversity. Items were measured on a 5-point Likert scale ranging from 1 (“Never true of me”) to 5 (“Always true of me”). The CD-RISC author reported that items were developed to assess a resilience score in a clinical population, with a higher score indicating a greater resiliency. Connor and Davidson [2] suggested five factors on the CD-RISC: Personal competence/tenacity (14 items), tolerance of negative affect (7 items), positive acceptance of change and secure relationships (5 items), control (3 items) and spirituality and belief of a higher power (2 items).

Data Analysis and Results

Data analysis was conducted in two phases. First, we conducted a confirmatory factor analysis to explore the structural validity of the resilience instrument used in this study for our sample. Second, we conducted internal reliability analysis to examine the reliability of the instrument and examined the construct validity of the instrument using the estimates of the Average Variance Extracted (AVE) and Maximum Shared Variance (MSV). Preliminary analysis conducted indicated that the data contained 0.7% of missing data. The amount of data missing in the study was negligible.

Confirmatory Factor Analysis (CFA): A CFA of the resilience measure was conducted using SPSS® AMOS software, to examine the data fit and structure of the latent subscales of the resilience measure. The model fit was evaluated using the criteria suggested by Hu and Bentler [18]. Good model fit indicated by Chi-square/df (PCMIN/df ≤ 2), Composite Fit Index (CFI ≥ 0.9), Root Mean Square Error of Approximation (RMSEA ≤ 0.06), Tucker Lewis Index (TLI ≥ 0.9). While other indices evaluate model fit, the indices provided above are the most adopted [19]. CFA results indicated that the five-factor structure of the resilience measure demonstrated a permissible fit to the data: Chi-square = 442.14, Chi-square/df = 1.668, RMSEA = 0.067, CFI = 0.857, TLI = 0.824. Figure 1 shows the model fit of the resilience measure.

Reliability and Validity Evidence: We examined the reliability of the 25- item CD-RISC measure. The internal consistency of the overall resilience measure was 0.92, suggesting that the CD-RISC internal reliability is considered good. We also estimated the internal consistency of the resilience sub-scales using the Composite Reliability coefficient. Values of CR greater than or equal to 0.70 are considered to have good internal reliability [20]. The internal reliability for the first four factors of the CD-RISC was above the recommended reliability value. However, the internal consistency for factor 5 was not as high as the first four factors (CR = 0.60). Scales of internal consistency between 0.60 and 0.70 are also considered acceptable [21].

Lastly, we examined two sources of validity evidence to establish the construct validity for the CD-RISC measure. The first source of evidence examined convergent validity through the Average Variance Extracted estimate (AVE). Convergent validity is achieved when AVE is greater than 0.5. Further, we examined discriminant validity through the estimate of Maximum Shared Variance (MSV). Evidence of discriminant validity is assumed when the estimate of the MSV is less than the estimate of the AVE, or the square root of AVE is greater than the inter-item correlations of the construct [20]. Results showed that only factor 1 of the CD-RISC achieved convergent and discriminant validity. The other factors of the scale had values below the threshold validity value. Table 1 shows the five resilience factors' internal consistency and construct validity evidence.

Table 1. Internal consistency, convergent validity, and discriminant validity estimates of the CD-RISC sub-scales.

		CR	**AVE**	**MSV**
CD RISC_1	**Personal competence & Tenacity**	0.72	0.56	0.24

		CR	AVE	MSV
CD-RISC_2	**Tolerance of negative affect**	0.82	0.37	0.94
CD-RISC_3	**Positive acceptance of change**	0.71	0.27	0.98
CD-RISC_4	**Control**	0.76	0.40	0.98
CD-RISC_5	**Spiritual influences**	0.60	0.34	0.89

Discussions

This study examined a measure of resilience - the Connor Davidson Resilience Scale (CD-RISC) using a sample of engineering students. Although Connor & Davidson suggested that the resilience measure is valid and reliable, structural validity efforts to support the five-factor structure across different populations have failed **[**16**]**. This paper applied confirmatory factor analytic methods to the resilience measure to evaluate its validity. The five-factor model yielded a marginal model fit. Also, the internal reliability coefficients for all factors were acceptable. The composite reliability coefficient was lower for the factor, named *spiritual influences*, perhaps explained by the fact that only two items load on the factor. The results of convergent validity and discriminant validity, indicated by the values of AVE and MSV, suggest the instrument had issues with construct validity. Further, we found that the correlation between personal competence and tenacity (factor 1) and positive acceptance of change (factor 3) of the CD-RISC (r = 0.95) suggests inter-related constructs between both factors. This inter-relationship indicates that both factors lack discriminant validity.

Future Directions

Despite the importance of resilience to students' academic well-being, no prior studies have documented validity and reliability support for well-cited resilience measures, such as the CD-RISC among college engineering students. Our study investigated the structural validity of the instrument with a sample of undergraduate engineering students. In future studies, we will conduct studies to compare different models of the CD-RISC proposed in prior study to determine how best to use the CD-RISC to facilitate resilience research among students in engineering contexts.

Although using larger samples relates to greater confidence in results [22], the sample size used in our analysis provides adequate interpretability of validity evidence of the resilience measure. The literature suggests that a sample size of 100 to 150 is acceptable for a CFA [23-26]. Following up on this study, we will explore the psychometric characteristics of the CD-RISC with a larger sample in order to explore the dimensionality of the instrument. Lastly, we will conduct studies that examine how resilience moderates student engagement in predicting academic achievement.

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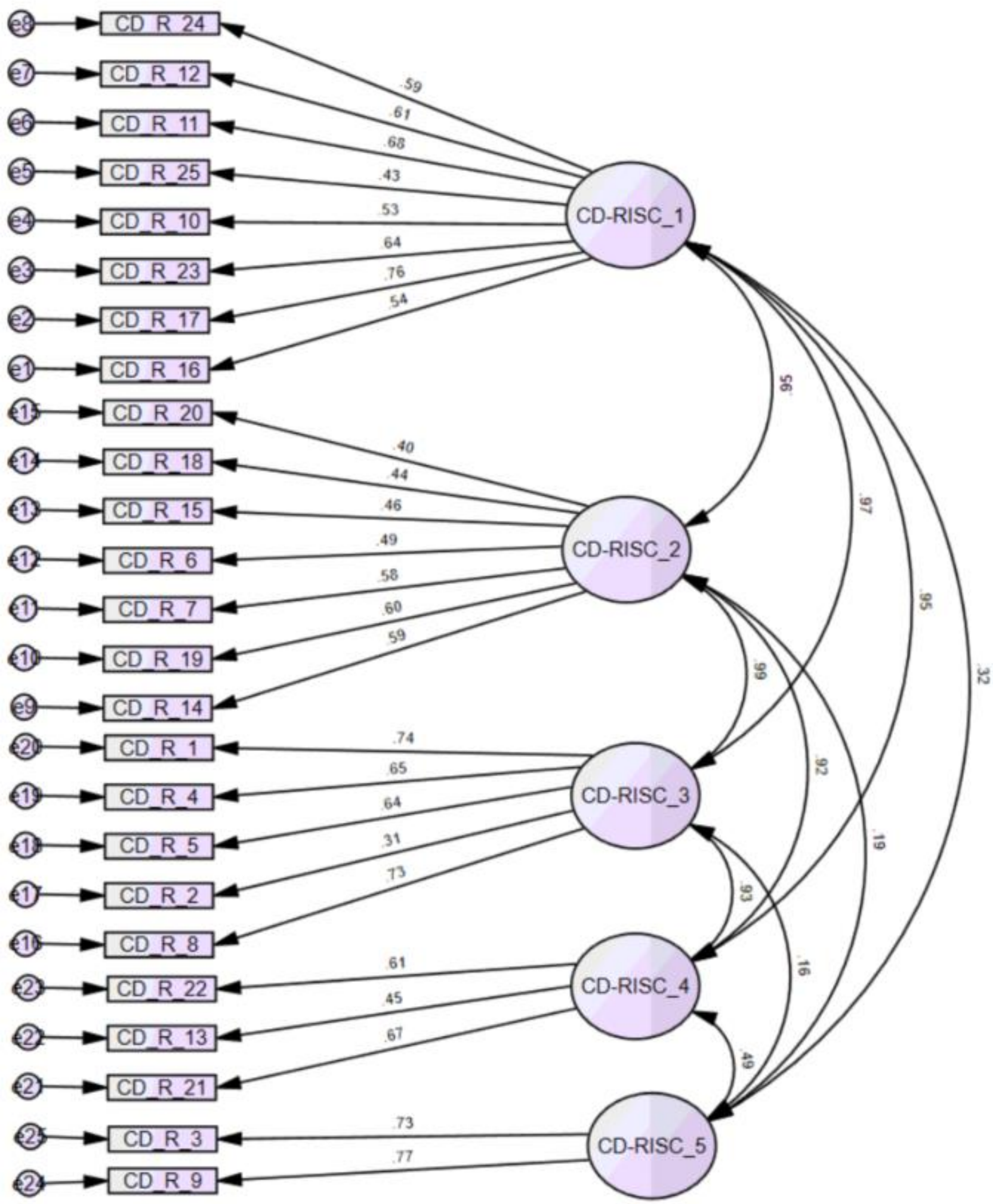

Fig. 1: Five-factor model of the 25-item CD-RISC scale