Development and Validation of the AMPERE Scale: Distinguishing Adaptive and Maladaptive Perfectionism in Engineering Students

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Development and Validation of the AMPERE Scale: A Domain-Specific Measure of Adaptive and Maladaptive Perfectionism in Engineering

Abstract

This theory paper presents the development and validation of the Adaptive and Maladaptive Perfectionism in Engineering (AMPERE) scale, a brief, domain-specific instrument designed to capture distinct manifestations of perfectionism among undergraduate engineering students. Drawing on multidimensional theories of perfectionism, AMPERE differentiates productive striving from concern-driven evaluative tendencies. Using expert review, cognitive interviews, exploratory and confirmatory factor analyses, and Rasch modeling, the scale demonstrated a stable two-factor structure. The final retained model (Model CB) demonstrated strong comparative fit (*CFI=0.966*, *TLI=0.960*) and acceptable absolute fit, with convergence across factor-analytic and item-level evidence. These findings support the structural validity and theoretical grounding of AMPERE, a measurement tool for engineering education research.

1 Introduction: Perfectionism in Engineering Education

1.1 Multidimensional and Domain-Specific Perfectionism

Perfectionism is commonly defined as the tendency to set and strive toward exceptionally high standards accompanied by critical self-evaluation [1]. Literature recognizes perfectionism as a multidimensional construct rather than a unidimensional personality trait [2], [3].

Multidimensional models emphasize that perfectionistic tendencies vary in their sources, expressions, and consequences, particularly across interpersonal and achievement contexts.

In parallel, domain-specific perspectives argue that perfectionism manifests differently across contexts [4]. Engineering education presents a distinctive domain characterized by iterative problem solving, high-stakes evaluation, and normative expectations of technical correctness. As a result, perfectionistic tendencies in engineering may be triggered and reinforced in ways not fully captured by global or cross-disciplinary instruments. Domain-specific measurement is therefore critical for accurately characterizing how perfectionism operates within engineering learning environments.

1.2 Adaptive vs. Maladaptive Perfectionism

A central distinction in perfectionism research differentiates adaptive and maladaptive forms of perfectionism [5], [6]. Adaptive perfectionism is associated with high personal standards, persistence, and motivation, and has been linked to positive outcomes such as self-efficacy [7] and task engagement [8]. In contrast, maladaptive perfectionism is characterized by high personal standards; however, it is associated with excessive concern over mistakes, fear of failure, self-criticism, and anxiety, depression, and avoidance behaviors [9], [10].

Importantly, adaptive and maladaptive perfectionism frequently co-occur within individuals, particularly in high-achieving academic settings. In engineering education, this overlap complicates the interpretation of students' performance-oriented behaviors, as outward indicators of diligence may mask underlying distress. Distinguishing these dimensions is therefore essential for both research and practice, motivating the need for instruments that explicitly operationalize adaptive and maladaptive perfectionism within engineering contexts. This study builds on prior conceptual work synthesizing perfectionism theories and measurement approaches in engineering education by advancing from theory to empirical scale development and validation [11].

2 The Challenge of Measuring Perfectionism in Engineering

Perfectionism has been examined across a range of student populations using established instruments, including the Frost Multidimensional Perfectionism Scale (FMPS) [2], the Hewitt and Flett Multidimensional Perfectionism Scale (MPS) [3], and the Almost Perfect Scale–Revised (APS-R) [12]. While these instruments have contributed substantially to understanding perfectionism, they were not designed for engineering-specific contexts and vary in how explicitly they distinguish adaptive and maladaptive dimensions.

Prior studies applying general perfectionism measures to engineering students have reported high levels of maladaptive perfectionism and associations with stress and disengagement [13], [14]. However, without domain-specific operationalization, it remains difficult to interpret whether observed patterns reflect engineering culture, measurement artifacts, or both. Moreover, many existing scales are lengthy or include dimensions less relevant to engineering learning, limiting their practicality for advising, mentoring, or program-level assessment.

A domain-specific, multidimensional measure that explicitly distinguishes adaptive and maladaptive perfectionism is therefore needed to support research on student success and to inform responsible educational interventions in engineering programs.

3 Limitations of Existing Perfectionism Measures

Existing perfectionism instruments exhibit three primary limitations when applied to engineering education. First, although many scales are multidimensional, they are not domain-specific and may

fail to capture contextual triggers unique to engineering curricula. Second, adaptive and maladaptive dimensions are often inferred post hoc rather than explicitly modeled, complicating interpretation for applied use. Third, scale length and construct breadth may reduce feasibility for integration into educational settings.

For example, the FMPS emphasizes concerns over mistakes and parental expectations but was developed in non-engineering populations [2]. The MPS captures the interpersonal dimensions of perfectionism but, by design, does not distinguish between adaptive and maladaptive forms [3]. Shorter instruments, such as the APS-R, explicitly assess adaptive and maladaptive dimensions but are not tailored to domains (e.g., engineering) [12]. Collectively, these limitations motivate the development of a concise, engineering-focused instrument that balances theoretical rigor with practical usability.

3.1 Multidimensional but Not Domain-Specific

Many established perfectionism instruments adopt a multidimensional structure, capturing constructs such as concern over mistakes, personal standards, or socially prescribed expectations [2, 3]. However, these dimensions were developed and validated in general or clinical populations and are not tailored to the contextual demands of engineering education. As a result, they may overlook domain-specific triggers such as iterative problem solving, grading practices that emphasize correctness, and cultures that normalize high evaluative pressure. Without explicit domain specificity, it remains unclear whether observed perfectionism patterns reflect individual tendencies or contextual features of engineering curricula. This limits interpretability for both research and applied educational use.

3.2 Adaptive and Maladaptive Dimensions Are Not Explicitly Modeled

Although prior work has distinguished adaptive and maladaptive forms of perfectionism conceptually, many existing instruments do not explicitly model these dimensions within their factor structures. Instead, adaptive and maladaptive tendencies are often inferred post hoc through combinations of subscales or correlational patterns [5, 6]. This approach complicates interpretation, particularly in applied contexts where clarity is essential for advising or intervention. In engineering education, where high standards are normative and often encouraged, the lack of explicit modeling increases the risk of conflating healthy striving with maladaptive self-criticism. An instrument that directly operationalizes both dimensions is therefore needed to support responsible interpretation.

3.3 Practical Constraints in Engineering Contexts

Beyond conceptual limitations, practical constraints further restrict the use of existing perfectionism measures in engineering education. Many scales are lengthy or include dimensions less relevant to academic engineering settings, reducing feasibility for integration into advising, mentoring, or program-level assessment. Instruments developed for clinical or general populations may also use language that lacks face validity for engineering students, limiting engagement and interpretability. For educational stakeholders, tools must balance theoretical rigor with brevity and contextual relevance. These constraints underscore the need for a concise, engineering-focused instrument designed with applied use in mind.

4 Methods: Development and Validation of AMPERE

A multi-phase research design was conducted to support the systematic development and validation of the AMPERE scale. This design was guided by established best practices in scale development and validation [15, 16] and modeled after Gattoni's (2018) validation framework for the Sport Adaptive and Maladaptive Perfectionism Scale (SAMPS), which similarly incorporated expert review, pre-testing, and large-scale survey administration [4].

These phases included: Phase I: expert reviews to establish content validity, Phase II: cognitive interviews to assess item clarity and face validity, and Phase III: large-scale survey distribution to evaluate the psychometric properties of AMPERE. Survey administration included the AMPERE instrument alongside established measures of perfectionism (MPS, APS-R) and decision-making avoidance (MIDC) to support construct validation. These study phases are situated within the broader scale development framework proposed by Boateng et al. (2018), explicitly indicating which steps of the nine-step process were implemented and which were intentionally omitted based on the methodological scope of this study (Appendix1).

Stage one included item development focusing on content validity rather than item generation, as AMPERE was adapted from an existing instrument through wording modifications to reflect the engineering domain (Gattoni's SAMPS; [4]). Stage one focused on assessing content validity through expert reviews. Stage two of Boateng's framework is called scale development, which is composed of the pre-testing of questions, sampling & survey distribution, item reduction and extraction of factors. In this study, the first two steps of pre-testing, involving cognitive interviews and survey distribution, were conducted. Finally, in the third and last stage, all steps, including tests of dimensionality (confirmatory factor analysis), reliability (such as Cronbach's alpha), and validity (such as correlation analysis), were conducted. Given space constraints, methodological reporting prioritizes decisions central to measurement development and validation.

5 Research Design

This study employed a cross-sectional research design to develop and validate the AMPERE scale. Cross-sectional designs are well suited for examining personality-related constructs and conducting psychometric validation at a single point in time [17]. The research design followed a three-phase scale development process aligned with best practices outlined by Boateng et al. [16].

Phase I (Expert Review) focused on establishing content validity through review by two domain experts—one specializing in perfectionism research and one in engineering student advising—who evaluated item relevance, clarity, and construct alignment [16, 18]. Inter-rater agreement indicated substantial consistency (κ = 0.805) [19].

Phase II (Cognitive Interviews) involved cognitive interviews with undergraduate engineering students to assess item clarity, interpretability, and alignment with Adaptive and Maladaptive perfectionism constructs. Using a think-aloud protocol [20], this qualitative pretesting supported face validity and ensured items were meaningful within engineering contexts [16, 21].

Phase III (Survey Administration) consisted of large-scale survey distribution to undergraduate engineering students at a large, land-grant institution in the southeastern United States. A final sample of 307 respondents met recommended thresholds for exploratory and confirmatory factor analyses [22, 23]. Data were screened prior to analysis to ensure they met the estimation requirements for factor analytic techniques [24]. This study was reviewed and approved by the Clemson University Institutional Review Board (IRB #2025-0641).

Together, this design enabled iterative item refinement, integration of qualitative and quantitative evidence, and robust evaluation of AMPERE's factor structure, reliability, and validity [15].

6 Results

Among several candidate models evaluated, the final model demonstrated adequate comparative fit and strong conceptual coherence (CFI = 0.966, TLI = 0.960, RMSEA = 0.089, SRMR = 0.094). Although absolute fit indices such as RMSEA and SRMR were slightly above conventional cutoff guidelines [25], model evaluation was guided by a holistic assessment that prioritized comparative fit, theoretical interpretability, and convergence across multiple analytic approaches. This approach is consistent with recommendations in the measurement literature, particularly for confirmatory factor analyses estimated using ordinal Likert-type data and robust estimators such as WLSMV [26, 27].

Prior methodological work has demonstrated that RMSEA and SRMR may be inflated in CFA models involving categorical indicators, relatively small degrees of freedom, or strong factor loadings, even when the underlying factor structure is theoretically sound and replicable [27]. In such contexts, comparative indices such as the CFI and TLI are often more informative for evaluating relative model adequacy, with values exceeding 0.90 commonly interpreted as indicating acceptable comparative fit for complex measurement models [26]. Consistent with this guidance, the CFI value observed for the Model CB (Appendix 1) supports the adequacy of the proposed two-factor structure when evaluated relative to alternative specifications.

Importantly, retention of Model CB was not based solely on fit indices. Results from exploratory factor analysis converged with the CFA solution, supporting the presence of two distinct yet related dimensions corresponding to adaptive and maladaptive perfectionism. In addition, Rasch analyses [28] provided item-level evidence that AMPERE items functioned as intended across the latent trait continuum, with ordered response thresholds, acceptable item fit statistics, and appropriate coverage of both lower and higher levels of perfectionism [29]. Hence, Rasch modeling was used to complement factor-analytic findings by evaluating item functioning and response-category behavior, not to re-specify dimensionality. The alignment of findings across EFA, CFA, and Rasch modeling strengthens confidence in the substantive validity of the final measurement structure beyond what could be inferred from any single analytic method. Exploratory factor analysis using principal axis factoring with oblique rotation supported a two-factor solution, consistent with parallel analysis and theoretical expectations. Sampling adequacy was strong (KMO = 0.83; Bartlett's test $p < .001$), and factor loadings aligned with the confirmatory solution. Internal consistency reliability for the final AMPERE subscales was acceptable. Cronbach's alpha (α) was 0.76 for Adaptive perfectionism and 0.85 for Maladaptive perfectionism, exceeding commonly recommended thresholds for early-stage scale development [30].

Several alternative models were examined during the confirmatory phase, including models that collapsed Adaptive and Maladaptive perfectionism items into a single factor and models that introduced additional cross-loadings or correlated residuals suggested by modification indices. Although some of these specifications yielded modest improvements in selected fit indices, they did so at the expense of conceptual clarity, parsimony, and alignment with the theoretical distinction motivating AMPERE. In keeping with best practices in scale development [16], modification indices were interpreted cautiously and were not used to justify post hoc model alterations that lacked substantive theoretical justification [31]. Fit statistics and parameter estimates for all alternative models are reported in Appendix 10.3) to support transparency and reproducibility.

Taken together, the model CB was retained based on its conceptual coherence, consistency with theory, and convergence across multiple analytic approaches. Rather than optimizing fit at the expense of interpretability, model evaluation focused on developing a stable, theoretically meaningful and practically useful measure of adaptive and maladaptive perfectionism in engineering education contexts. This approach reflects a growing consensus in psychometric research that fit indices should inform, rather than dictate, model selection decisions, particularly in early-stage instrument development and validation studies [15, 26].

7 Discussion

7.1 Overview

The present study aimed to develop and validate the AMPERE instrument to distinguish between Adaptive and Maladaptive manifestations of perfectionism in undergraduate engineering students and to situate these constructs within a broader network of established perfectionism measures and a theoretically relevant academic outcome. Beyond scale development, this study provides empirical insight into how perfectionistic tendencies manifest within engineering education, highlighting patterns of adaptive striving, concern-driven perfectionism, and their associations with decision-making avoidance.

Accordingly, this discussion is organized around the development and validation of the AMPERE scale as a domain-specific measure for engineering students including implications for advising, mentoring, and student support.

7.2 Development and Validation of the AMPERE Scale

Following rigorous data screening that reduced the initial $N = 383$ Qualtrics responses to a final analytic sample of $N = 307$ undergraduate engineering students, descriptive distributions of study variables fell within ranges acceptable for robust structural modeling with Likert-type data [32]. The validation strategy intentionally relied on multiple, converging sources of evidence rather than a single analytic criterion, consistent with best practices in psychometric scale development.

First, convergent and discriminant validity were examined through associations with established multidimensional perfectionism instruments (MPS and APS–R), situating AMPERE within the broader perfectionism literature. Second, criterion-related validity was evaluated using decision avoidance (MIDC) as a theoretically relevant, non-perfectionism construct. This approach was grounded in prior work suggesting that perfectionistic concerns often shape academic behavior through hesitation, avoidance, and difficulty committing to decisions under uncertainty [33]. Third, exploratory factor analysis supported the existence of two underlying dimensions corresponding to Adaptive and Maladaptive perfectionism, followed by confirmatory factor analyses to evaluate competing measurement models.

Confirmatory modeling began with the full 20-item baseline model and proceeded through a sequence of reduced models (Model A and Model B), culminating in the final retained specification (Model CB). Model CB demonstrated the most favorable balance between statistical adequacy and conceptual clarity, with an acceptable comparative fit index ($CFI = 0.966$, TLI=0.960) and acceptable absolute fit (RMSEA = 0.089; SRMR = 0.094), supporting the empirical separability of adaptive striving and concern-driven perfectionism. Although RMSEA and SRMR approached or slightly exceeded conventional cutoff values, these indices were interpreted cautiously in light of the ordinal nature of the data, the use of WLSMV estimation, and prior methodological work documenting inflation of RMSEA and SRMR in similar conditions. Importantly, model evaluation emphasized convergence across EFA, CFA, and Rasch analyses, as well as theoretical interpretability, rather than optimization of any single fit statistic.

To further understand the internal structure of the scale, modification indices were examined to identify item-level overlap and inform future refinement. Three pairs of items merit particular discussion.

7.2.1 Interpretation of Rasch Results

Rasch analyses complemented the factor-analytic findings by providing item-level evidence of scale functioning. Ordered response thresholds indicated that students used the response categories in a predictable and interpretable manner. Item difficulty estimates aligned with theoretical expectations: Adaptive items were easier to endorse and clustered at lower trait levels, while Maladaptive items required higher levels of the latent trait. Response–item maps demonstrated adequate coverage of the perfectionism continuum, suggesting that AMPERE captures a broad range of experiences without major measurement gaps. Together with CFA results, the Rasch findings support the structural validity, internal consistency, and measurement precision of Model CB as the final operationalization of AMPERE for engineering students.

8 Implications for Engineering Education Research and Practice

AMPERE provides a concise, domain-specific instrument for measuring adaptive and maladaptive perfectionism within undergraduate engineering contexts. By explicitly modeling striving and evaluative concern as separable dimensions, the scale offers greater interpretive clarity than global or post hoc multidimensional measures. For researchers, AMPERE enables more precise investigation of perfectionism within engineering education, supporting future studies examining academic outcomes, well-being, persistence, and instructional context. For practitioners, the scale offers a theoretically grounded measurement tool that may inform

advising and mentoring efforts, while emphasizing that high standards and evaluative concern represent distinct psychological processes. As a measurement instrument, AMPERE is intended to support responsible research and contextual interpretation rather than diagnostic or intervention use. Continued validation across institutions and populations will further clarify its applicability and boundaries.

9 Conclusion

This study contributes to engineering education research by developing and validating the AMPERE scale, a domain-specific instrument that distinguishes Adaptive and Maladaptive perfectionism among undergraduate engineering students. By separating productive striving from concern-driven evaluative tendencies, AMPERE addresses a measurement gap in a field where high standards are normative.

Using a multi-phase validation process incorporating expert review, cognitive interviews, factor-analytic techniques, and Rasch modeling, AMPERE demonstrated a stable two-factor structure supported by converging sources of evidence. As an initial single-institution validation, this work establishes a foundation for further refinement, cross-institutional replication, and examination of measurement invariance across engineering subdisciplines.

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10 Appendix

10.1 Scale Development and Validation Process [16]

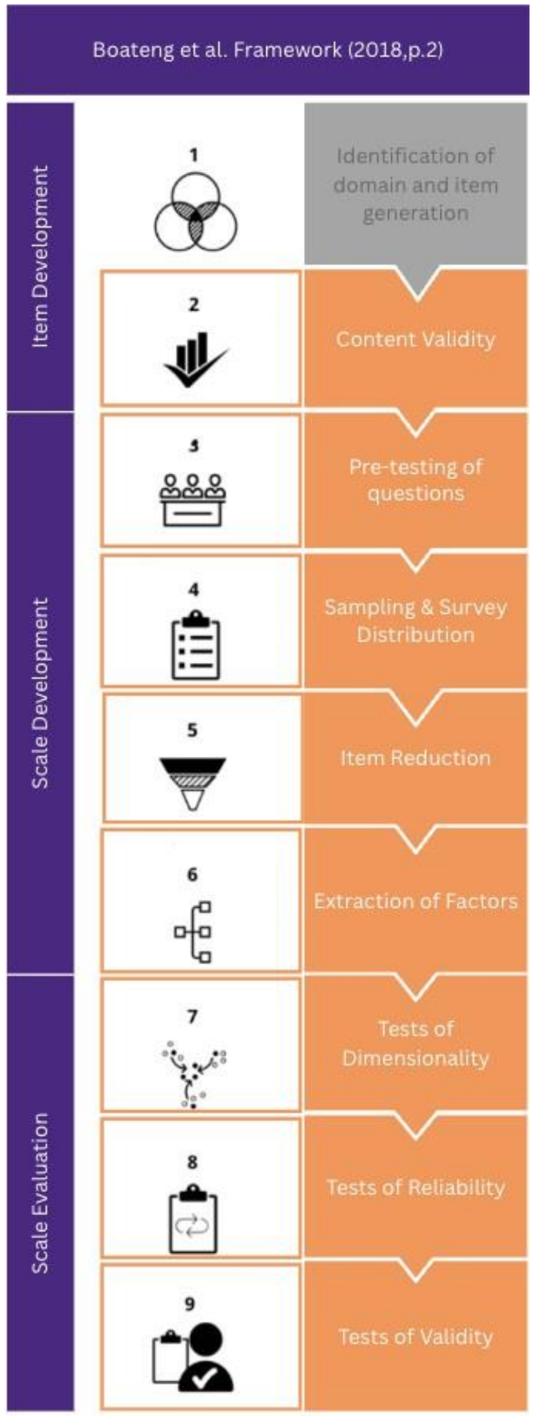

Figure 1: Overview of the three stages and nine steps of scale development and validation, adapted from Boateng et al. (2018). Steps implemented in the present study are shown in orange, while gray indicates steps not implemented due to the study's methodological focus.

10.2 AMPERE Final Items (19 items)

Item	Statement
1	I set high standards for my academic performance in my engineering studies.
2	I enjoy working to achieve greater levels of precision and accuracy in my engineering studies.
3	Doing my best in my engineering studies never seems to be good enough for me.
4	No matter how well I do, I don't feel satisfied with my academic performance in my engineering studies.
6	No matter how much I study for my engineering classes, I feel underprepared going into an exam.
7	My academic performance in my engineering studies doesn't meet my own standards.
8	I feel ashamed if I perform less than perfectly in my engineering studies.
9	I enjoy challenging myself to set high standards for academic performance in my engineering studies because it makes me a better student.
10	Striving to do my best in my engineering studies keeps me motivated.
11	I trust my capabilities to meet the high standards that I have set for myself in my engineering studies.
12	If I make a mistake in my coursework, an exam, an assignment, or a project, I feel like a failure as an engineering student.
13	I am motivated to work diligently until I meet my academic performance goals in my engineering studies.
14	I strive for excellence in my engineering studies.
15	I often feel frustrated because I cannot meet my achievement goals in my engineering studies.
16	I often worry about not meeting my own expectations in my engineering studies.
17	My successful academic performance in engineering studies motivates me to set higher standards.
18	I am unsatisfied with my accomplishments in my engineering studies.
20	I usually have trouble deciding when I have prepared enough for my engineering coursework, exams, assignments, or projects.

10.3 CFA Fit Indices for Models M20, A, B, B11 and CB

Table 2: CFA fit indices for AMPERE models (WLSMV, θ parameterization).

Model	Total Items	CFI	TLI	RMSEA	$RMSEA_L$	$RMSEA_U$	SRMR
M20	20	0.895	0.882	0.145	0.134	0.156	0.134
A	19	0.891	0.877	0.155	0.143	0.167	0.140
B	18	0.915	0.903	0.143	0.130	0.155	0.131
B11	17	0.958	0.951	0.103	0.089	0.117	0.104
CB	14	0.966	0.960	0.089	0.071	0.107	0.094