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A LightGBM-Based Analysis of Academic Resilience Among Gifted Students with Twice-Exceptional Profiles: Contributions of Metacognitive Awareness, Emotional Regulation, and Perceived Teacher Support

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1. Round 1

1.1. Reviewer 1

Reviewer:

The paragraph beginning with “Among the various factors associated with academic resilience, metacognitive awareness has received substantial scholarly attention” presents strong justification for metacognition but does not sufficiently explain why metacognitive awareness was expected to outperform emotional regulation and teacher support. The authors should articulate specific hypotheses regarding the relative predictive strength of each variable.

In the final paragraph of the Introduction, the sentence “Machine learning methods provide powerful alternatives capable of identifying intricate predictive patterns and estimating the relative importance of multiple contributing factors simultaneously” is conceptually appropriate; however, the manuscript should explain why LightGBM was selected over other machine-learning algorithms such as Random Forest, XGBoost, CatBoost, or Support Vector Regression. A comparative rationale would strengthen methodological rigor.

In the Study Design and Participants section, the statement "A total of 428 gifted students with documented twice-exceptional profiles participated in the study" requires greater procedural detail. Please clarify the identification criteria for giftedness and exceptionality, including IQ thresholds, diagnostic procedures, educational records, and whether standardized assessments were used consistently across provinces.

In Table 3, metacognitive awareness is reported to account for "43.82% of the total predictive contribution within the model." Because feature importance measures in tree-based models can be influenced by variable scale and distribution, the authors should discuss potential biases associated with gain-based importance metrics and justify their interpretation.

The paragraph describing Table 4 indicates that "Metacognitive awareness achieved the highest mean absolute SHAP value (12.48)." To enhance interpretability, the authors should supplement global SHAP values with local explanation examples demonstrating how predictor values influenced resilience predictions for individual participants.

Figure 1 presents the SHAP summary plot; however, the visualization lacks information regarding feature interaction effects. Since resilience is theoretically multidimensional, the authors are encouraged to examine and report SHAP interaction values to determine whether teacher support moderates the effects of metacognitive awareness or emotional regulation.

Authors revised the manuscript and uploaded the document.

1.2. Reviewer 2

Reviewer:

The sentence "Participants were recruited from specialized gifted education programs, inclusive educational settings, and support centers serving students with exceptional learning needs across the provinces of Ontario, British Columbia, and Alberta" raises questions regarding sampling representativeness. The authors should provide the number of participants recruited from each province and educational setting to evaluate potential sampling bias.

In the Measures section describing the Academic Resilience Scale (ARS-30), psychometric evidence from previous studies is reported; however, reliability coefficients for the current sample are absent. Cronbach's alpha, McDonald's omega, or composite reliability estimates should be presented for all instruments used in the study.

The paragraph describing the Metacognitive Awareness Inventory states that it contains "52 items designed to assess individuals' awareness and regulation of cognitive processes." Given the age range of participants (12–18 years), the authors should justify the developmental appropriateness of the instrument and indicate whether any adaptations or readability checks were conducted.

In the Data Analysis section, the sentence "The dataset was randomly divided into training (80%) and testing (20%) subsets" requires further elaboration. Please indicate whether stratified splitting procedures were used to preserve the distribution of twice-exceptional categories and demographic characteristics across datasets.

The statement "Hyperparameter optimization was performed using five-fold cross-validation combined with grid-search procedures" is insufficiently detailed. The manuscript should report the parameter search space, the number of candidate models evaluated, and the criteria used for selecting the final model. These details are essential for reproducibility.

In the Findings section, the paragraph reporting demographic characteristics notes that "Missing data represented less than 2% of all responses and were handled using multiple imputation procedures." Please specify the imputation method employed (e.g., MICE, predictive mean matching), the number of imputations performed, and whether sensitivity analyses were conducted to verify robustness.

In Table 1, the reported correlation between academic resilience and metacognitive awareness ($r = .71$, $p < .01$) is relatively high. The authors should assess and report multicollinearity diagnostics such as Variance Inflation Factors (VIFs) or tolerance statistics to ensure that predictor overlap did not influence model interpretation.

Regarding Table 2, the statement "The model explained 84.7% of the variance in academic resilience scores within the testing dataset" is impressive; however, additional evaluation metrics such as adjusted R^2, explained variance score, residual distribution analyses, and calibration plots would provide a more comprehensive assessment of predictive performance.

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2. Revised

Editor's decision: Accepted.
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