Leadership, Learning, and Business Beyond Boundaries: Managing Change in a Complex World
21–23 May 2026
Ljubljana, Slovenia
make learn TIIM PIConf
Management, Knowledge and Learning International Conference
Technology, Innovation and Industrial Management
Sustainable Development

Predicting Engineering Students' Satisfaction with Mathematics Grades Using Ordinal Regression

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Abstract

Studying satisfaction of engineering students with mathematics is essential because a strong relationship between more positive attitudes and better performance. Moreover, an increase in students' retention, and more active engagement with complex technical frameworks are critical for managing engineering programs since mathematics courses are the foundation of students' continuation into advanced engineering studies. Also, the satisfaction feeling indicates the level of students' confidence which minimizes the probability of dropping out and retake. The exploratory study develops an ordinal regression model to predict students' satisfaction with their mathematics grades initially using eight factors (i.e., Cognitive, Affective, Behavioral, Socio-Economic, Background-Foundation, Learning Strategies, Perceived Teaching Quality, and Study Support Environment Factors) derived from prior literature. Satisfaction is reflected by an academic grade that a student receives.

This study aims to identify forecast students' satisfaction with their mathematics grades. The investigated determinants include cognitive, affective, behavioral, socio-economic, academic preparedness, learning strategies, teaching engagement, and external/contextual factors. A structured questionnaire using a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) was developed, comprising eight factors with five items each, along with one item measuring grade satisfaction. The instrument was pilot-tested with 30 students to assess reliability and clarity, and revisions were made accordingly. The finalized questionnaire was distributed to Industrial Engineering students from Years 1 to 4 using convenience sampling, and ordinal regression analysis was applied to examine the determinants of mathematics grade satisfaction. The survey data were randomly divided

into training and testing sets using an 80/20 split. The 80% subset was used to develop the ordinal regression model, while the remaining 20% was reserved to evaluate its predictive performance.

Due to its complex nature, using an exploratory study is appropriate to help identify essential variables which accurately influence satisfaction. The accuracy is important when developing the ordinal regression model to avoid including too many irrelevant variables. Based on the survey responses from 315 students, the results demonstrate that only Cognitive, Behavioral, Learning Strategy, Perceived Teaching Quality, and Study Support Environment Factors significantly relate to satisfaction among Industrial Engineering students. The term cognitive intends to strengthen analytical and problem-solving skills of students when faced with challenging mathematical problems. Behavior reflects desirable actions needed to complete the course successfully. Learning strategy helps students select appropriate methods that lead to desirable behaviours while overcoming rote learning or memorization which is not suitable for mathematics. Teaching quality highlights more active participation by students who are self-motivated. The term study support environment implies sufficient resources required to support teaching and learning.

The confusion matrix shows that the model performs well on the training data, achieving an overall accuracy of 73.41%, with particularly strong prediction for Medium Satisfaction (86.02%), followed by Very High and High Satisfaction. However, accuracy declines for extreme categories (Low and Very Low Satisfaction), indicating greater difficulty in classifying these levels even in-sample. In contrast, performance drops substantially in the testing data, with overall accuracy decreasing to 30.16%, demonstrating limited generalizability and clear overfitting. Although most misclassifications occur between adjacent categories—an acceptable pattern for ordinal outcomes—the large gap between training and testing performance suggests the model is more appropriate for screening or ranking purposes rather than precise category prediction on new data.

The model shows practical value for identifying students at risk of repeated course registration and delayed graduation which affects planning and scheduling of engineering programs. Although the findings are specific to Industrial Engineering students and grade satisfaction as a surrogate for performance, the approach provides useful insights for early intervention and instructional design. This exploratory study underlines the significance of both student-related factors such as motivation and university-related factors, including teacher support when addressing quality of teaching and learning, coursework preparation, and even in-service training for instructors due to the large classroom size which is common in basic mathematics.

Because this study involved a limited sample size, the results cannot be generalizable in other circumstances such as online courses. Also, the study views the scope of satisfaction of mathematics as internal without much influence from outside, e.g., employment opportunity. Finally, this study focuses solely on the context of industrial engineering students. As a result, more investigations into other student groups such as those who are in non-engineering degrees and students from other engineering disciplines required to register mathematics. Even, more advanced engineering courses for last-year students

should be evaluated. Thus, future studies should extend the model to different contexts so that it can incorporate additional variables to improve its predictive accuracy.

Keywords: Performance Satisfaction, Mathematics, Ordinal Regression, Industrial Engineering