Work In Progress - Predicting Retention in Engineering using an Expanded Scale of Affective Characteristics from Incoming Students

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Abstract - Earlier research published by the authors has demonstrated an improvement in prediction capability when incorporating nine affective characteristics into a artificial neural network retention model with eleven cognitive factors. Models developed previously have achieved moderate success with overall prediction accuracy above 70%. In this follow-up study, in order to develop new knowledge on relationships between other affective factors and student persistence, and further improve our capability to predict students’ retention, five carefully selected affective characteristics are added to the existing retention model. These promising new affective factors are: goal orientation, implicit beliefs, intent to persist, social climate and self worth.

New retention models based on logistic regression and neural networks are developed to identify the significant predictors among these new affective characteristics, and evaluate the overall predictive performance of new models incorporating them. The prediction accuracy results of models using only these new factors, as well as models including both new and existing factors are then compared with performance of previously published models. Upon completion of this project, confirmed significant predictors and their effects on predictive retention models will be reported. The potential engineering education applications based on these new findings will also be discussed.

Index Terms – Affective characteristics, Artificial Neural Networks, first year retention, predictive modeling.

INTRODUCTION

Studies have used cognitive data (e.g. standardized test scores, high school GPA) to predict student retention after the first year [1, 2]. In an effort to increase the accuracy of predictions, hybrid retention models making use of Artificial Neural Networks (ANN) were developed using affective measures from an existing scale [3]. Nine affective factors (i.e., academic self efficacy, academic motivation, leadership, meta-cognition, major indecision, propensity for deep learning, propensity for surface learning, teamwork vs. individual orientation and expectancy-value) along with eleven cognitive factors (i.e., standardized test scores, high school GPA, average grades and number of semesters in high school mathematics/science/English courses) serve as independent variables to the ANN with retention in engineering as the dependent variable. In addition, these affective data have been shown to be repeatable and stable over time using McDermott’s three-stage cluster analysis [4, 5]. The hybrid ANN models based on these combined factors have achieved an overall prediction accuracy above 70%, with 40% of the non-persistent students being identified successfully while the over-estimation (bias) for not retained students were controlled at a 30% level [3].

In an effort to further improve the identification of non-persistent students, the authors incorporated five additional non-cognitive characteristics in the AAN model. These new characteristics were supported by literature to be promising as predictors of retention, including items from student’s perception of social climate and elements of attribution theory; specific factors are: goal orientation, implicit beliefs, intent to persist, social climate and self worth. Cohort data has recently been collected for engineering students entering their first year of study at a large, Midwestern university using the complete instrument assessing all fourteen affective characteristics.

This paper addresses the following research questions: 1) what are the more significant predictors of student retention in engineering among goal orientation, implicit beliefs, intent to persist, social climate and self worth? 2) How accurate can a neural network predictive model using these five factors predict students’ retention in engineering after their first year, especially for those non-persistent students? 3) How is the prediction performance using these new factors compared with that of previously reported models using existing factors?

METHOD

Data for this study were based on first-year students (N =1711) who entered a large, Midwest University as engineering majors during the 2007-2008 academic year. The data set included: students’ scores on fourteen self-report, affective measures that were completed the summer prior to the freshman year. Nine of these affective measures were reported earlier [3,4,5], including: academic self-efficacy, motivation, leadership, metacognition, major decision, deep learning, surface learning, teamwork and expectancy-value. Support for these scales’ reliability and
construct validity based on the results of factor analyses has been previously published [4,5]. The newly added five characteristics are: goal orientation, implicit beliefs, intent to persist, social climate and self worth. Both existing and new affective items were developed in 5-point Likert scales and administered to students in an on-line survey system. The cognitive factors in this study include students’ high school academic performance and standardized test results. Students’ retention status (being retained in engineering programs or not) were collected at the beginning of their second year in college.

The cognitive factors and affective measures serve as the independent variables, while student’s retention status is the dependent variable in these retention models. Logistic regression models, as a traditional statistical technique [1, 6], are developed to identify the significant predictors for student retention. Artificial neural network models, popular in prediction and classification problems in data-intensive engineering and business applications, are used to model the complicate relationship between cognitive/affective factors and student retention in engineering.

MODELS AND EXPECTED RESULTS

Retention models with predictor inputs from 1) five new affective factors only, 2) both new and existing (totally 14) affective factors, and 3) all cognitive and affective factors will be developed. Their prediction performance will be validated through K-fold cross-validation process and compared with results reported in previous studies.

The expected new knowledge and contribution obtained from completion of this study include: 1) identifying the significant predictors for retention among the five new affective characteristics 2) comparison of the predictive power between the new factors and the existing factors, 3) improving the understanding of student retention in engineering by incorporating deserving new affective factors into the current retention models.

REFERENCES


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