Examining Student Engagement in Online Learning Platforms for Promoting Exam Readiness and Success in Undergraduate Nursing Education

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ABSTRACT

Promoting students' readiness and first-time success on the National Council Licensure Examination for Registered Nurses (NCLEX-RN) is an important driver of investigations and interventions in undergraduate nursing education. However, few studies have linked nursing students' engagement in online learning platforms to their exam performance. We address this gap in the field by applying feature engineering and prediction modeling to engagement and outcome data available for approximately 600 students enrolled in the Bachelor of Science in Nursing program for registered nurses (BSN-RN) from 2015-2022 at a mid-size private university in the Southern U.S.

We derived a total of 185 features from datasets capturing student engagement in two online learning platforms; namely, Elsevier's Adaptive Quizzing (EAQ) and Sherpath. These features reflected patterns of student activity on and performance in assignments and quizzes (e.g., ratio of total completed assignments to distinct completed, longest answer streak). We then created prediction models to identify the EAQ and Sherpath features that were associated with strong performance on (a) Health and Environmental Sciences Institute (HESI) Exit Exams (E2), a high-stakes standardized assessment, and success on (b) the NCLEX-RN.

The best performing classification models are able to correctly distinguish 80% of the time between students who attained a E2 score of at least 850 and students who did not (AUC ROC=0.80). The model for predicting whether a student passes the NCLEX-RN on their first attempt was able to distinguish those students from students who did not pass, 64% of the time (AUC ROC=0.64). The regression models predicting average E2 score and number of NCLEX-RN attempts had a root mean squared error (RMSE) of about 0.81 and 0.87 standard deviations, respectively.

This examination has enabled us to recommend ways in which nursing educators can enhance their use of Sherpath and EAQ, particularly towards identifying and supporting students that require additional curricular intervention to improve their performance on E2 and the NCLEX-RN. We conclude this paper with future directions for research and practice for nursing educators interested in facilitating learning at scale.

KEYWORDS

Feature engineering, Predictive modeling, Exam readiness, Online learning platforms, Nursing education

1 Introduction

Online learning platforms are increasingly used by university faculty to supplement classroom instruction. In the field of nursing education, online learning platforms are tailored to help students prepare for the Health and Environmental Sciences Institute (HESI) Exit Exams (E2) and National Council Licensure Examination for Registered Nurses (NCLEX-RN). Given that end-of-program and licensing exams typically come after the conclusion of a student's educational program, their engagement with and performance within an online learning platform can provide a valuable "pulse-check" on their exam readiness.

Online learning platforms amass a significant volume of student engagement data. While individual program faculty may not have the technical capabilities needed to assess students' exam readiness based on platform engagement data, prediction models could be trained to identify students who are off-track. As a result, these prediction models could trigger automated interventions that steer students towards engagement patterns closely associated with success on the E2 and NCLEX-RN. The platforms could also notify faculty that students are off-track or receiving low scores on certain topics that matter for licensing exams.

To explore the potential for such interventions, this investigation takes the form of a case study in partnership with administrators at the nursing college of a mid-size private university in the Southern U.S. We developed prediction models to identify engagement behavior associated with exam passage by linking seven years (2015-22) student outcome data on key assessment (E2 and NCLEX-RN) and engagement data from two online learning platforms (EAQ and Sherpath). This paper shares results from model development and highlights the ongoing process of designing and deploying automated interventions in the online learning platforms.

2 Background

In the United States, students enrolled in Associate Degree in Nursing (ADN) or Bachelor of Science in Nursing (BSN) programs seeking to become Registered Nurses (RNs) must pass the NCLEX-RN to demonstrate competence to potential employers. In a typical year, three in four students pass the NCLEX-RN on their first attempt [1], whereas others retake the exam until they achieve a passing grade. Recently, Shah and colleagues [2] reported that a score of 850 and above on the E2 is highly indicative of first-time success on the NCLEX-RN for students of both types of RN programs. Gouveia, Thielk and Sportsman [3] found that students who took more HESI Specialty Exams, a skills assessment, performed significantly better on the E2; the former were more likely to meet the recommended E2 benchmarks of 850 or 900. Furthermore, Shah and colleagues [4] found that RN programs that reported having specific test preparation requirements (e.g., EAQ) for the E2 had statistically significantly higher student NCLEX-RN first time pass rate (94%) than programs that did not have any specific test preparation requirements. Specifically, Hirsch [5] found that students who used computer-based adaptive quizzing had higher E2 scores compared to the NCLEX-RN review textbook preparation group; albeit, this study was conducted in the context of an ADN program.

The field has long been interested in identifying factors that can predict students' success on the NCLEX-RN (e.g., [6]) with a handful of studies using statistical approaches such as logistic regression [7, 8]. However, these investigations are mostly small-scale, both in the number of participants and the time frame. No known study in this area has applied data mining techniques such as feature engineering and machine learning models (e.g., classifiers, regressors) to identify and test predictors of E2 and the NCLEX-RN using student engagement data from online platforms that are typically used for test preparation and remediation (e.g., Sherpath, EAQ). The aforementioned gaps and trends provide impetus for the current study.

3 Data sources

This study obtained NCLEX-RN outcomes for 684 exams from 2015 to 2022, reflecting 584 students enrolled in a BSN program from 2015-2022 at a mid-size private university in the Southern U.S. To prepare for the NCLEX-RN and gain core competencies, students at the nursing college supplemented their classroom learning with two online learning platforms, Sherpath® and Elsevier Adaptive Quizzing (EAQ). Both are products of Elsevier. We obtained datasets on Sherpath and EAQ engagement from Elsevier for 576 students and 656 students, respectively. These datasets contained information on assignments and questions, with scores and timestamps for individual assignments and questions and details about the topics of questions. In total, we obtained data reflecting roughly 78,000 assignments and more than 1 million questions.

In addition to the online learning platforms, the nursing college uses HESI® exams, another Elsevier product. HESI exams included Custom Exams, tailored by programs for their specific needs; Specialty Exams, to evaluate learning in a specific topic area or discipline; and Exit Exams (E2), to assess readiness for the NCLEX-RN as students approach graduation. We obtained datasets on all three exam types for 879 students, of whom 605 took at least one E2.

4 Analysis

Our primary interest was to examine how Sherpath and EAQ engagement shape NCLEX-RN readiness. However, NCLEX-RN passage is a binary variable. As a result, we cannot distinguish between test-takers who pass by small margins and test-takers who pass by large margins. Therefore, we were also interested in investigating how Sherpath and EAQ engagement shape E2 scores. As described earlier, a higher E2 score is known to closely correlate with higher likelihood of passing the NCLEX-RN [9, 4].

Preliminary analysis found that using Sherpath and EAQ are associated with better performance on the NCLEX-RN. Students who used Sherpath at the participating institution outperformed those who did not use Sherpath on E2 and NCLEX-RN, and the same is true of EAQ. (See Table 1). More than 97% of students who used both EAQ and Sherpath attained a E2 score of 850 or above, and nearly 80% of them passed the NCLEX-RN on the first attempt; by comparison, only 69% of those who used neither Sherpath nor EAQ attained an 850 or above on the E2, and only 74% of them passed the NCLEX-RN on the first attempt.

In order to build a prediction model to assess the types of engagement that are most closely associated with success on the NCLEX-RN and E2, we derived 102 student-level variables from the Sherpath and EAQ data. We refer to these variables as "engagement indicators"; they include assignment and question completion, students' self-reported confidence, answer correctness and streaks, participation over time and daily streaks of usage, and time spent on the platforms. In addition, we derived 83 variables that reflect students' performance on topics in EAQ that are important for passing the NCLEX-RN. We refer to these variables as "high-impact topics," and they include topics such as "Heart and Neck Vessels," "Respiratory Dysfunction," "Disorders of the Stomach and Upper Small Intestine," and "Ethics and Values."

After linking data on our 185 independent variables to our data on E2 and NCLEX-RN outcomes, we assessed each indicator's ability to predict performance on the E2 and the NCLEX-RN through three methods: Spearman's correlations, effect sizes, and single-feature decision trees. (See Table 2). Accounting for the results for each of the 102 engagement indicators and 83 high-impact topics, we identified 15 engagement indicators and 19 high-impact topics with relatively stronger relationships to E2 and NCLEX-RN performance.

Using this set of 34 independent variables, we generated models predicting E2 score (continuous), E2 score at or above a threshold of 850 (binary), NCLEX-RN passage (binary), and number of NCLEX-RN attempts before passing (continuous). (See Table 3). For all models we employed 10-fold cross-validation to validate that models will work on new students, and for classifier models we used Synthetic Minority Over-sampling Technique (SMOTE) to balance the prediction training datasets.

5 Results

Results indicate that student engagement in EAQ and Sherpath can predict attainment of an E2 score of 850, first-time NCLEX-RN passing, average E2 scores, and total NCLEX-RN attempts. (See Table 4).

For the classifier models, data derived from Sherpath and EAQ are able to very successfully predict whether a student attains a E2 score of at least 850, with AUC ROC of 0.805, a degree of performance seen in medical diagnostic tests used in real-world situations [10]. Contrastingly, the model predicting whether a student passes the NCLEX-RN on their first attempt achieved considerably lower performance (AUC ROC=0.636).

We see a similar pattern for the regression models, where the model that best predicts the average E2 score has a smaller RMSE relative to the scale of the target variable (0.81 standard deviations) than the model that best predicts the number of NCLEX-RN attempts before a pass (0.86 standard deviations). While we are primarily interested in predicting NCLEX-RN success as an outcome, the additional information available through E2 scores encourages us to consider interventions that could improve E2 scores as well.

The variables that had strong influence on the best-performing models can serve as guides for designing nudge interventions for nursing programs using Sherpath and EAQ. For instance, instructors may receive a message when students' progress with assignments or students' total number of questions answered is lower than expected. Similarly, students may receive pop-up messages when they are frequently submitting 'confidently incorrect answers', missing questions in high-impact topics, or have not logged into EAQ/Sherpath recently. (See Table 5.)

6 Discussion, Conclusions and Implications

This study seeks to equip nursing programs with new indicators to identify students at risk of failing the NCLEX-RN early in their education. This early identification can allow for timely intervention with additional mentoring to boost NCLEX-RN performance [11]. We find that prediction models built on online learning platform engagement indicators can detect many students at risk of failing the NCLEX-RN or needing multiple NCLEX-RN attempts, though less well than we can predict scores on the E2. However, these findings reflect data obtained from one participating institution. As such, we will continue refining these models and investigating generalization.

As next steps, we are planning to integrate these interventions into the EAQ and Sherpath, with the 2024-25 academic year targeted for deployment. Following deployment of the interventions for one year in the BSN program at the participating institution, we will assess the interventions' effectiveness at increasing online learning platform engagement and improving performance on the E2 and the NCLEX-RN.

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