

Using Early Quizzes to Predict Student Outcomes in Online Introductory Biomedical Informatics Courses

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Background & Problem

- Need for informatics education
 - Especially introductory courses
- Relatively constrained number of qualified educational programs
- Increasing use of online education
 - Larger class sizes
 - Traditional cues not available
 - Eye contact
 - Verbal interaction
- Can use data available at time of admission [1], but may not have data for non-degree-seeking students.
- Problem: How do you identify students at risk for poor performance early?

Learning Management Systems

- Widely used
- Collect a variety of data
 - Passive data collection: Activity logs
 - Active data collection: Weekly quizzes

Hypothesis

Students at risk for non-successful completion (drop, fail or grade $\leq C$) can be identified by poor performance on the first few weekly quizzes.

Methods

1. Collected weekly quiz scores for each student along with final course outcome for
 - a) Foundations of Health Information Sciences I (F1) at the School of Biomedical Informatics, UT-Houston
 - b) Introduction to Medical Informatics (IMI) at the University of West Florida (UWF).
2. Course outcomes (binary)
 - a) Non-Successful Completion (NSC)/non-NSC
 - b) Failure/not Failure
 - c) Completion/non-Completion

Introductory Informatics Courses

Foundations 1 Pre-Midterm	Foundations 1 Post-Midterm	Intro to Medical Informatics First Half-Semester	Intro to Medical Informatics Second Half-Semester
Introduction; Models	Computer-based Patient Records	Overview of Medical Informatics; Patient Informatics	Mobile Technology; Networks
Information, Information Systems	Clinical Decision Support	Online Medical Resources; Search Engines; Evidence Based Medicine	Patient Safety and Technology; E-Prescribing
Medical Computing	Computers in Med Education	Clinical Practice Guidelines; Disease Management and Registries; Pay for Performance	Telehealth and Telemedicine; Picture Archiving and Communication Systems; E-Research
Medical Decision Making	Imaging Systems	Electronic Health Records; Integrated Practice Management Systems; Interoperability	Bioinformatics; Public Health Informatics; Emerging Trends
Standards	Information Retrieval; Consumer Informatics		
Evaluation & Tech Assessment	Public Health Informatics		
	Bioinformatics		

Results

Week(s)	Area under ROC Curve (AUC)		PPV (75% Threshold)	NPV (75% Threshold)	# "at risk" students at SBMI of 205 total
	AUC	95% CI			
1	0.7380	0.6705-0.8055	44.3%	77.8%	43
1+2	0.7912	0.7303-0.8521	57.9%	77.8%	37
1+2+3	0.8333	0.7773-0.8892	61.9%	82.4%	40
1+2+3+4	0.8627	0.8123-0.9131	69.0%	87.1%	57

Threshold = 75% (chosen as the highest score where false positives = false negatives)

Results

- UTH F1: 205 students (Spring 2007 – Spring 2010)
- UWF IMI: 42 students (Fall 2009)
- Non-Successful Completion: F1 = 28.8%; IMI = 18%
- Only 57/205 F1 students (27.8%) and 6/42 IMI students (14.3%) scored below 75% on the first four quizzes.
- Quiz scores at both institutions skewed toward higher scores.
- Prediction was not statistically different between the three semester types (Spring vs. Summer vs. Fall).
- Same model applied to IMI data yielded a positive predictive value (PPV) of 83.3% and negative predictive value (NPV) of 91.7%.
 - Comparison to human instructor:
 - Human:
 - Sensitivity for NSC = 71.4%
 - Specificity = 90.9%
 - PPV = NPV = 83.3%.

Conclusions

While representing only 6% to 8% of the total grade, the first four quizzes are highly predictive for course outcome. Using only the first two quizzes available by the UT add/drop deadline still allows prediction, but with a lower PPV. Automated prediction generalizes across institutions and compares favorably to human instructor prediction.

References

1. Willcockson IU, Johnson CW, Hersh W, Bernstam EV. Predictors of student success in graduate biomedical informatics training: introductory course and program success. J Am Med Inform Assoc. 2009 Nov-Dec;16(6):837-46.

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