Curricular Innovation through a Focus on Academic Analytics

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The Challenge

• “...the real promise of opportunity depends on completing, not just pursuing, a bachelor’s degree.” (E.M. Tobin, 2009)

• Two aspects
  – Retention
  – Attainment

• Multi-dimensional problem
Institutional Correlations

Math ACT and Graduation Rates: 46 Research 1 Flagship Universities

$R^2 = 0.7248$
IT’S NOT THAT SIMPLE…
Academic Analytics

• Employment of statistical and data mining tools to academic data sets with the goal of revealing trends and patterns, and building predictive models to improve student success through evidence-based interventions.
  – Identify students at risk
  – Monitor student progress
  – Recommend pathways
The Paradigm—From Personalized Medicine...

Figure 2. Hierarchical clustering of patient samples based on differentially expressed genes (P<0.01) obtained from comparing good prognosis versus poor prognosis in the USC group and EAC group, respectively.

...to Personalized Learning...

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with Abhishek Mondal, Zi Lin, and Subrahmanya Bhat (grad students in Computer Science, UMTC) and funding from HHMI and Distinguished McKnight Professorship funds
The Data Deluge

• Inter-institutional data
  – Correlations among indicators across peer institutions
  – Average ACT
  – Instruction expenses per FTE
  – Percent part-time enrollment
  – ...

• Intra-institutional data
  – Enrollment
  – Registrar
  – Student affairs
  – Academic affairs
  – ...

• Individual student data
  – ACT, HS GPA, financial aid,
  – Graduation Planner
  – CMS
  – ...

Efforts at Other Institutions

- Baylor University: enrollment management
- University of Alabama: freshman retention
- Sinclair Community College: early alert system
- Northern Arizona University: effective deployment of student resources
- Purdue University: use of CMS to identify students at risk
- ...

...
How did they do it?

• Apply statistical and data mining tools to past and current students to identify indicators that predict outcomes, such as dropping out, low GPA, etc.
  – GPA
  – English grade/Math grade
  – Total earned hours
  – CMS usage
  – ...

• Almost all efforts are restricted to building of predictive models that are applied to new students to identify at-risk students
ACADEMIC ANALYTICS—THE VISION
Going Beyond Freshmen...

• 4-yr personalized advising approach
  – For students at all levels of performance throughout their undergraduate career, not just at-risk freshmen
  – Dashboard for SLOs, SDOs
  – Integrated with CMS, e-portfoliо, graduation planner, library, tutoring centers, academic advising, career planning,…
  – Recommender system for resources and opportunities
Qualities

• Low maintenance
• Coarse-grained assessment at large scale
• Integration across curriculum
• Recommender system
• Effective link to student resources
• Effective link to advising
• Validation of model at smaller scale
What can we do with this?

• Scaling
  – Models based on coarse-grained indicators can be implemented on large campus

• Fine-grained approach to understand mechanistically why or why not students succeed
  – Validation of coarse-grained indicators
  – Development of interventions
Fine-grained Assessment

- Qualitative and Quantitative Assessment
- Data
- Data Mining Tools and Statistical Tools
- Hypotheses and Experiments
- Predictive Models of Student Learning and Model Validation
What’s Needed?

- Commitment to evidence-based decision making
- Analysts
- Software developers
- Flexible technology platform to collect data
- Data warehouse

EFFORTS AT UMR
University of Minnesota Rochester (UMR)

• Established in 2006
• Small campus
  – Center for Learning Innovation
  – No departments
• Focus on health sciences
• Programs
  – B.S. in Health Sciences
  – B.S. in Health Professions
  – Graduate program in biomedical informatics and computational biology
  – Partnership programs
UMR’s Effort

• Design faculty (T/TT) have a mandate through the 7.12 statement to engage in research on learning
  – IRB approved fine-grained research
• iSEAL
  – Curriculum development tool
  – Tagged learning objects → modules → course
  – Curriculum delivery
  – Assessment across the curriculum based on concepts and encounter tags
• Student-based faculty (instructors)
• Student Affairs: Student Coaches
• IT reports to Academic Affairs
Assessment of SLOs

- Top-down curriculum design
- Courses are divided into units/modules
- Each unit/module has learning objectives that are assessed
- Each learning objective is mapped to a Student Learning Outcome
Illustration

• Learning Objective: after completion of this module, the student will be able to
  – explore “social, economic and environmental development at local, national and global levels” with Gapminder
  – perform and interpret logarithmic transformations for graphical display
  – download global health data from Gapminder and WHO
Activity

• Click on “Database” in the left-hand column and “Browse the GHO database”
• Export the data to a .csv file
Implementation

Student Learning Outcomes: **Can locate** and critically evaluate **information** from a diversity of media

Learning Objectives: **download global health data from WHO**

Assessment: **assess whether student can find appropriate data and download as .cvs file**
Research Tool: iSEAL
Annotation of Learning Objects

• Encounter (Structure)
  – Dataset
  – Image
  – Research article
  – ...

• Function
  – Concepts
## Annotation of Assessment Objects

**Encounter (structure)**
- Midterm question
- Clicker question
- Survey question
- ...

**Function**
- Summative assessment
- Formative assessment
- Attitudinal survey
- ....

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iSEAL Database

- Learning Objects
- Assessment Objects
- Student data
  - Grades
  - Surveys
  - Artifacts
  - ...
- ...

![Diagram of iSEAL Database with connections to learning objects, assessment objects, student data, and other unspecified items.]
Learning Database

- K-12 Database
- iSEAL Database
- Other Database

- Mine data from multiple dimensions
- Accumulate data from main and auxiliary databases
- Select sensible and relevant patterns

Knowledge Database (KBD)

- Incoming students profile
- Map profile to KDB
- Predict/Recommend a path or career track for the student

DECISION MAKING SYSTEM
Discussion Points

• What are the opportunities of academic analytics?
  – Role of technology in the curriculum
  – Role of technology in student affairs
  – Role of technology in advising

• What qualities should academic analytics have?

• How can we use academic analytics for personalized education to broaden opportunities for an increasingly diverse student body?

• How do we raise awareness of the potentials of academic analytics within the academy?

• What are obstacles to the adoption of academic analytics?

• What are the limitations of academic analytics?