Learning from Every Student: Leveraging Learning Analytics to Support Success in Higher Education

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Data Science for Education

We have been doing research on educational data for a long time…

What's changed?

- We know more about learning
- Explosion of online educational platforms
- New forms of data about learning “digital trail/footprints”
Learning Analytics is…

The measurement, collection, analysis and reporting of data about learners and their contexts for purposes of understanding and optimizing learning and the environments in which learning occurs.
Actionable Research: Data to Knowledge to Practice

Goal = Create Data-Driven Academic Pathways to Success
Goals for Learning Analytics Research
Brief History of LA @ UM

- Integrated student data warehouse established
- Individual faculty projects (e.g., my early work)
- Symposium on Learning Analytics at Michigan (SLAM)
- Provost-supported Learning Analytics Task Force
- Creation of Office of Academic Innovation
- Identified thrust area for new Michigan Institute for Data Science (MIDAS)
- Host SoLAR’s learning analytics summer institute (LASI 2016 & 2017)
Goals for Learning Analytics @ UM

- Provide an integrated **student data ecosystem** for research leading to student success
- Create **unique a test bed** for investigating student learning
- Demonstrate **value and scalability** of existing and future high-value applications
- Protect **student privacy** while maximizing usefulness of data
Two Examples of Current Research Aimed at Supporting Student Success

Curricular Pathways – Assessing how the organization of classes affects student performance

Student Dashboards - Understanding how student-facing dashboards can be designed to promote meta-cognitive skills
Investigating the Impact of Concurrent Course Enrollment

Are we setting some students up for academic difficulty by requiring them take combinations of courses in the same semester?

Brown, DeMonbrun & Teasley (in press)
*Journal of Learning Analytics*

Fig. 5: Curricula-Courses Bipartite Network.
Using Institutional Data to Investigate Curricular Pathways

What are students’ changing risks of academic difficulty related to curricular pathways?

- Instructional Complexity = difficulty, quality, support
- Structural Complexity = order, organization, interdependence

And for whom?

- Which are factors related to students’ experiencing academic difficulty?
Study Design

**Focal course:** Introductory programing taught in our college of engineering

**Pre-requisite** for computer science & computer engineering, also taken by non-majors

**Sample** = 987 students (Fall 2016)

- 38% women
- 44% white & 38% Asian
- 33% first year, 36% second-year
Performance Metric: Weekly EWS Status

Green = Encourage
Above the class mean

Yellow = Explore
Below the class mean

Red = Engage
Lowest quartile
Measures

Student Explorer status in focal course, by week (green, yellow, red)

Course difficulty rating = % students who experience academic difficulty: more than 25% Engage, more than 10% Explore)

Major = 4 groups by discipline (Biglan, 1973: hard/soft, pure/applied)

Math placement score

Year of study = 1st, 2nd, upper class (other demo = ns)
When Do Students Get into Academic Difficulty?

*Bad news: Entering an *Explore* or *Engage* category in focal course*

Adding a difficult course = 12x greater odds of entering *Explore*

*Snowball effect for difficult courses*

- If *Explore* +1 course = 2x greater odds of entering *Explore* in 2\textsuperscript{nd} course
- If *Explore* +2 courses = 4x greater odds of entering *Explore* in 3\textsuperscript{rd} course
- If *Engage* +1 course = 3x greater odds of entering *Engage* in 2\textsuperscript{nd} course
- If *Engage* +2 courses = 7x greater odds of entering *Engage* in 3\textsuperscript{rd} course
Results: Entry Model

Entry Models for Time Coefficients

Hazard Estimate for Entry

Weeks into Semester

EXPLORE   ENGAGE
When Do Students Get Out of Academic Difficulty?

*Good news:* Exiting an *Explore* or *Engage* category in focal course

Adding a difficult course
- 4x greater odds of exiting *Explore*
- 2x greater odds of exiting *Engage*

Snowball effect
- No significant difference in odds of recovery for # of courses at *Explore* or *Engage*
Results: Exit Model
Student Factors:  
Non-Majors vs. Majors

Enter
- Explore: more likely for all but hard/applied majors
- Engage: more likely only for soft/applied majors

Exit
- Explore: less likely for all but hard/applied majors
- Engage: less likely for all but hard/applied majors
Student Factors: Demographic Variables

Enter

Math Score
  - Explore: higher = less likely
  - Engage: ns

Year of Study
  - Explore: ns
  - Engage: 1st year = less likely

Exit

Math Score
  - Explore: higher = more likely
  - Engage: higher = more likely

Year of Study
  - Explore: 1st year = more likely
  - Engage: 1st year = more likely
Summary (1)

- Co-enrolling difficult courses = increases odds of **entering** at risk category but increases odds of **exiting** at risk category.
- Many students can “dig themselves” out of trouble, especially first year students, but those students already underperforming in multiple courses are less likely to recover.
- Students whose major aligned with the focal course do better.
- Students with higher math skills do better.
Summary (2)

Timing matters = odds of entering at risk category increases until mid-semester, but odds of exiting start to decrease before then.

• There may be a temporal window for academic recovery, especially for students taking courses outside of their major and those with lower relevant foundational skills (e.g., math for computer science courses).
What Can We Do with these Findings?

• Identify the degree of difficulty in different course pathways
• Identify high risk courses for intervention
• Enhance the development of Early Warning Systems and performance dashboards
Student-Facing Dashboards

“We don’t need more stinking dashboards.”

A. Wise, LAK’13
Why Student-Facing Dashboards

• Becoming ubiquitous in LMS
• Enable students to monitor their progress and compare their performance against that of their peers
• Goal = support metacognition and self-regulation
Need for Research

Bodily and Verbert (2017) reviewed 93 studies of systems presenting some automatically generated data to students.

- Reported visualization design = 0
- Did needs assessment = 6
- Did usability testing = 10
- Studied effect on student behavior = 15
Learner (un)Dashboards

- Are students able to interpret the information provided, and do they know what to do with it?

- Which students find this information motivating versus demotivating, and under which circumstances?
Welcome back, Zoe.

You made it through the first statistics exam.

You scored
Here is what

Points Distribution

Your Score: 18,250
Class Average: 13,312
Low Score: 225 points
High Score: 19,535

How do I read this chart?
What can y
Gateway Course I

How Am I Doing?

You're doing really well in Gateway Course I. Consider reaching out to another student for study help!

Current Class Status

- **Setsuko Myles**
  - StudentName@UnizinUniversity.edu
  - Contact Instructor
  - 79.5% current score

2 Flags:
- Your current course score is 79.47%. You are in danger of failing this course.
- Averaging 83.9% over 49 assignments. That is below the class average of 91.3%.

![Graphs showing assignments and quizzes](image-url)

Outcomes

Assignments
- Section Avg vs Student

Quiz scores graph
- Section Avg vs Student

Activity vs Grade graph
- Assignment # vs Grade
Study 1: Experiment

- We asked undergrads to think about a past course that was important to them
- Presented dashboard images with activity and performance information (from Blackboard)
- Asked the students to talk about these
- Surveyed them after session about their overall assessment of the value of the information
Study Design 2

- 2 (condition: High/Low Performance Feedback) X 2 (GPA: High/Low) Design
- Participants = 47
- Face-to-face 20-30 min experimental session
- 3 Dashboard views (early, mid & late in semester)
- Post-session survey
Results

<table>
<thead>
<tr>
<th>High GPA</th>
<th>Low GPA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High Feedback</strong></td>
<td><strong>Low Feedback</strong></td>
</tr>
<tr>
<td>most found the grade graph useful, but their reasoning varied</td>
<td>reactions were mixed, some discouraged &amp; others motivated to work harder</td>
</tr>
<tr>
<td><strong>High Feedback</strong></td>
<td><strong>Low Feedback</strong></td>
</tr>
<tr>
<td>doubts about the accuracy and value of information, ambivalent about motivational value</td>
<td>wanted more transparency &amp; suggested actions that might help to improve grades</td>
</tr>
</tbody>
</table>
Results (continued)

Low GPA students

more motivated to take immediate action based on alerts

High GPA students

less likely check dashboards and turn on notifications

All students

who received low feedback were significantly more likely to find follow-up actions useful
Study 2: Course Deployment

• We gave undergrads access to Course Monitor dashboard (appeared as tool in Canvas)
• Could use it through whole semester
• Collected log data of use
• Surveyed them at end of term about their overall assessment of the value of the information
Results

All students

low frequency of use over term

All students

comparative performance view was rated higher than just seeing own

All students

reported minimal effect on students’ time & effort in course
Conclusions, so far…

• Most students found the dashboard visualizations informative and liked the comparative performance feedback

• Most students expressed interest in having such a dashboard available to them in theory, although most students didn’t access it much in practice
What is the unDashboard?

• A set of learning analytics visualizations for students

• Focus on providing information that promotes meta-cognitive skills
  – Help students reflect on what they are currently doing
  – Help students plan and modify behaviors to improve learning outcomes
The unDashboard Development Team

UMSI - Matt Kay, Carl Haynes
SoE - Stuart Karabenick
LSA - Reed Coots
ITS - Zhen Qian, Jennifer Love, Melinda Kraft, Mengdan Yuan, Pushyami Gundala, John Johnston, Matt Jones
On the Files Page

- **Home**
- **Announcements**
- **Assignments**
- **Discussions**
- **Files**
  - **My Learning**
  - **Analytics**
  - **Grades**

### Student Analytics Demo Course > Files

<table>
<thead>
<tr>
<th>Name</th>
<th>Date Created</th>
<th>Date Modified</th>
<th>Modified By</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>course_image</td>
<td>Apr 27, 2016</td>
<td>Apr 27, 2016</td>
<td>Jennifer Love</td>
<td>93 KB</td>
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<tr>
<td>Modules</td>
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<td>82 KB</td>
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<td>unfiled</td>
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<td>Canvas_Roles_Permissions.pdf</td>
<td>May 5, 2016</td>
<td>May 5, 2016</td>
<td></td>
<td>230 KB</td>
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</table>
Files Accessed

Use the slider to select a different time period

Use the dropdown to select files viewed by different student rankings

Mouse over to view more details about your file views

Click the filename to download the file

Use the brush to see more or fewer files
Assignment Planning

Mouse over assignments to see detail

Select which assignments to show by weight

Scroll to see assignments for upcoming weeks
On the Grades Page

Grades for Test Student

Arrange By

<table>
<thead>
<tr>
<th>Name</th>
<th>Due</th>
<th>Score</th>
<th>Out of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Updated quiz for testing</td>
<td>Mar 13 by 11:59pm</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

Total: N/A

Assignments are weighted by group:

<table>
<thead>
<tr>
<th>Group</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments</td>
<td>0%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>
Grade Distribution

Number of students: 208
Average grade: 86.5

Mouse over to see your grade (in percentage)
What’s Next?

• Currently piloting with 3 courses for Fall
• Research dashboard usage and solicit student feedback to improve the visualizations
Research Questions

• What are students’ viewing preferences (i.e. for individual vs. comparative performance feedback)?

• How do students’ use of the dashboard affect their assessment of their performance?

• Are there different effects of dashboard use on different kinds of students?
What Can We Do Now?

• Build models of student behavior to diagnose students’ academic challenges -> effective interventions before failure
• Design personalized learning trajectories that address the diversity of students & their preparation for learning at specific types of higher ed institutions
• Create interfaces for advisors, faculty & students to make data visible, understandable, and valuable
• Evaluate interventions, revise theory, re-design tools…
How Can We Help Students?

Build, design, and implement effective interventions before failure occurs
Make data visible, understandable, and valuable to academic advisors, faculty & students
….nudge, not push (no “helicopter analytics”)
Big Vision for LA Research: Where Do We need to Go?

• Use institutional data to innovate teaching & learning
• Develop new models for effective instruction and fair assessment
• Create shared datasets that allow cross-institutional analyses
• Assume risks of exposing what does and doesn’t work in higher ed - and for whom
• Maintain trust with stakeholders by clear privacy principles
Many Thanks to:

LED Lab students
UM faculty & staff colleagues
SoLAR community
Contact me at:
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