

Jorge Klor de Alva

President, Nexus
Research and Policy
Center





Technology Working to Transform Information into Education

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President

Nexus Research and Policy Center

Changing the landscape of higher education

- 
- Technology coming to the fore
 - Changing what information means
 - Transforming the academic experience
 - Promoting access
 - Improving the process
 - Facilitating completion
 - Using data and analytics as drivers

Information abounds through open educational resources

- **Free educational content**
 - Textbooks
 - Multimedia
 - Lessons



... including “massive open online courses” (MOOCs)

- Entire courses:

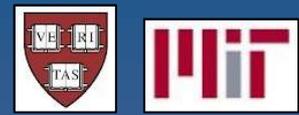


Over 1 million users, ~16 universities, ~116 courses in math, sciences, medicine, etc.
Venture Capital

11 courses (math, physics, CS)
113k+ active students & instructors
Venture Capital

120k students in MITx’s Circuits & Electronics course (Mar 2012)

~20 courses, ~10k students in 2011; foundations in cognitive tutoring & learning science



However, students expect (and most need) education to give them more than just access to information

- *Information to be useful must be curated:*
 - **Structured:**
 - Student authentication (is this the right student?)
 - Instructor of record, accredited, recognized (especially by employers)
 - Formal activities and milestones
 - **Personalized:**
 - Collect data, create profiles, track progress, adapt to individual
 - **Interactive:**
 - Active engagement
 - Social relationships

So—beyond courses—credits and degrees can be earned through relatively low cost “curators”

- Traditional institutions of higher education are no longer the only gatekeepers
- Competency-based education
 - Portfolios
 - Certificates
 - Digital badges
 - Standardization of competencies



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\$2890/6-month term



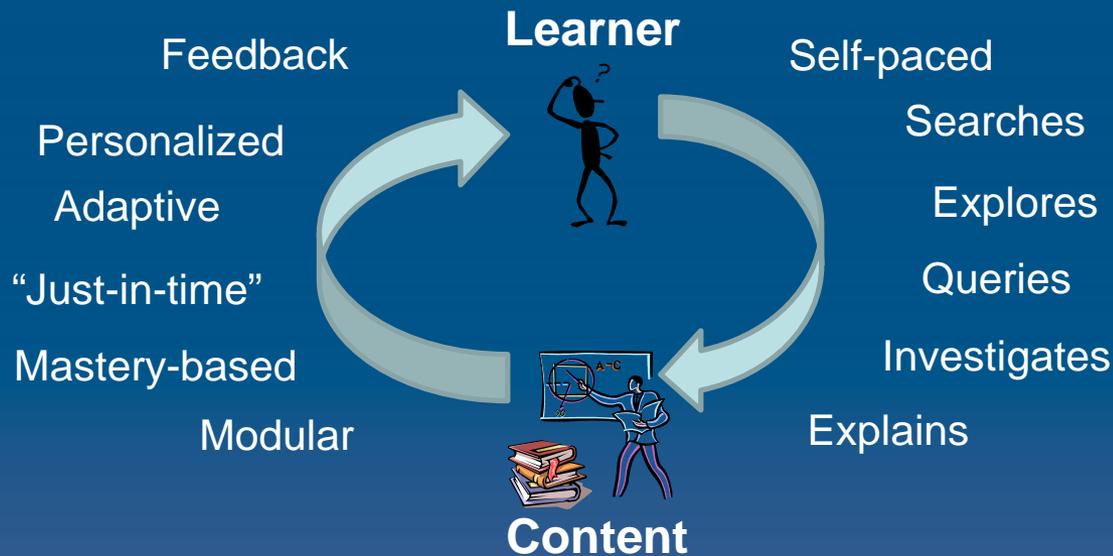
Lumina[™]
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mozilla
OPEN BADGES

But effective education requires transforming information into useful tools for students and educators

- This requires **academic analytics** to predict (and boost) enrollment, retention, progression and completion
- “Flipped” classrooms that focus on interactions, where learning takes place by doing, not merely absorbing

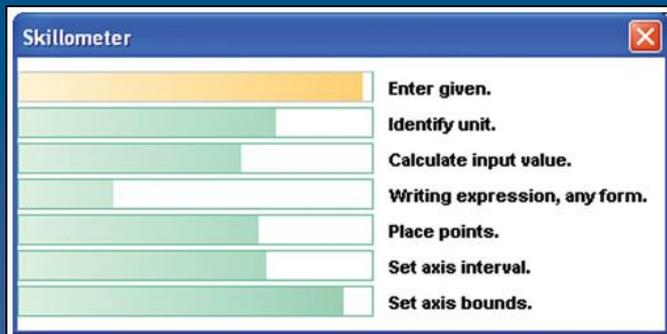


Supplemented by technology-mediated social interactions that promote active learning

And applying *learning analytics* to create student profiles and customize learning interactions

Adaptive Learning: To personalize feedback and help adapt instruction to individual learners' needs by:

- Analyzing learning materials
- Targeting gaps in knowledge
- Examining student knowledge and behaviors in Learning Management and Intelligent Tutoring systems
- Tracking multiple student paths to identify successful interventions for specific learning profiles



(1) Carnegie Learning "Skillometer": <http://www.carnegielearning.com/galleries/4/>

(2) ALEKS Learning report: http://www.aleks.com/about_aleks/learning_mode

Adaptive Learning Conceptual Model



The user facing web software:

- Student Interaction
- Faculty Interaction
- Dashboards
- Interactions with the system



Instruction Model

Data informed view of the learner:

The longitudinal data base of all interactions with the students that roll up into a student's "competency map"

Adaptive & Personalization Processes



Learner Profile

Knowledge Model

Meta-data about what is taught: All content and curriculum



Knowledge Check: Student Dashboard

Provides valuable feedback to students so they know how well they are learning and can correct errors as needed

This improves performance and helps to keep students engaged and motivated

Week 4 Knowledge Check

The purpose of this Knowledge Check is to check your understanding of concepts related to the topics and objectives for the week. At the conclusion of this Knowledge Check, you will receive a personalized study guide that directs you to resources that will help you master the material.

No attempts left. Total 10 questions | No time limit

2. Which of these statements best describes a complete individual business cycle?

1st Attempt D. movement from trough to expansion then to peak

✘ Incorrect.

2nd Attempt A. movement from peak to trough to peak

✔ Correct.

A business cycle is measured peak to peak or trough to trough.

[Next >](#)

Week 4 Knowledge Check

[Download Week 4 Knowledge Check study guide](#)

The material presented below is not meant to be a comprehensive list of all you need to know in the content area. Rather it is a starting point for building your knowledge and skills. Additional study materials are recommended in each area below to help you master the material.

Personalized Study Guide Results: Score: 6 / 10

Concepts	Mastery	Questions
Stages in the Business Cycle	67%	1 2 3
Level of Economic Growth	100%	4
Level of Unemployment	75%	5 6 7 8
Inflation	0%	9 10

Concept: Stages in the Business Cycle

Mastery 67% **Questions** 1 2 3

Materials on the concept:

- Business Cycles, Unemployment, and Inflation
- The Business Cycle
- Phases of the Business Cycle
- Causation: A First Glance
- Figure 26.1 The business cycle.
- Cyclical Impact: Durables and Nondurables

1. Business cycles occur when output

✘ 1st Attempt A. falls below its potential

B. rises above its potential

✘ 2nd Attempt C. is fixed at its potential

D. fluctuates around its growth trend

✘ Incorrect: The business cycle includes the tendency for output to rise and fall in the short term. When output fluctuates around an economy's secular trend, business cycles occur.

Materials

- Phases of the Business Cycle

2. Which of these statements best describes a complete individual business cycle?

✔ 2nd Attempt A. movement from peak to trough to peak

B. movement from recession to expansion

C. movement from peak to recession to trough

✘ 1st Attempt D. movement from trough to expansion then to peak

✔ Correct: A business cycle is measured peak to peak or trough to trough.

Materials

- Figure 26.1 The business cycle.
- Phases of the Business Cycle

3. During the business cycle, the period between the point at which output reaches a high and the point at which it reaches a low is called

✔ Correct: A downturn describes the phenomenon

The Carnegie Learning-based Step-By-Step Math Review provides an opportunity to build pre-algebra skills through adaptive practice

The service is adaptive at a highly granular level, providing intelligent, input-specific hints and feedback

The screenshot shows a math problem-solving interface. At the top, there are navigation buttons: "GO TO MAP", "GO TO LESSON", "MOD 3 UNIT 1 Equivalent Fractions SEC 1", and "BLIT". Below this, there are tabs for "STEP BY STEP" and "HINT". The main content area is titled "Part-to-Whole Model" and contains the text: "Use the model to find the equivalent fraction." Below this, the equation $\frac{5}{12} = \frac{?}{24}$ is displayed. A text prompt asks: "Enter the number of $\frac{1}{24}$ pieces that are equivalent to each $\frac{1}{12}$ piece." A text input field contains the number "2". To the right, a fraction model is shown as a grid of 24 columns and 2 rows. The top row is labeled "1 Whole = $\frac{12}{12}$ ". The first 5 columns of the top row are shaded blue and labeled " $\frac{5}{12}$ ". A red box highlights the number "10" in the input field. A feedback pop-up box points to the "10" and contains the text: "10 You're close. You've correctly identified the numerator, but you need to enter a fraction."

Highly intelligent feedback is responsive to the **specific misconception** the student demonstrates

Each student's session is highly personalized, based on mastery demonstrated with highly granular skills, tracked for every input of multi-step problems

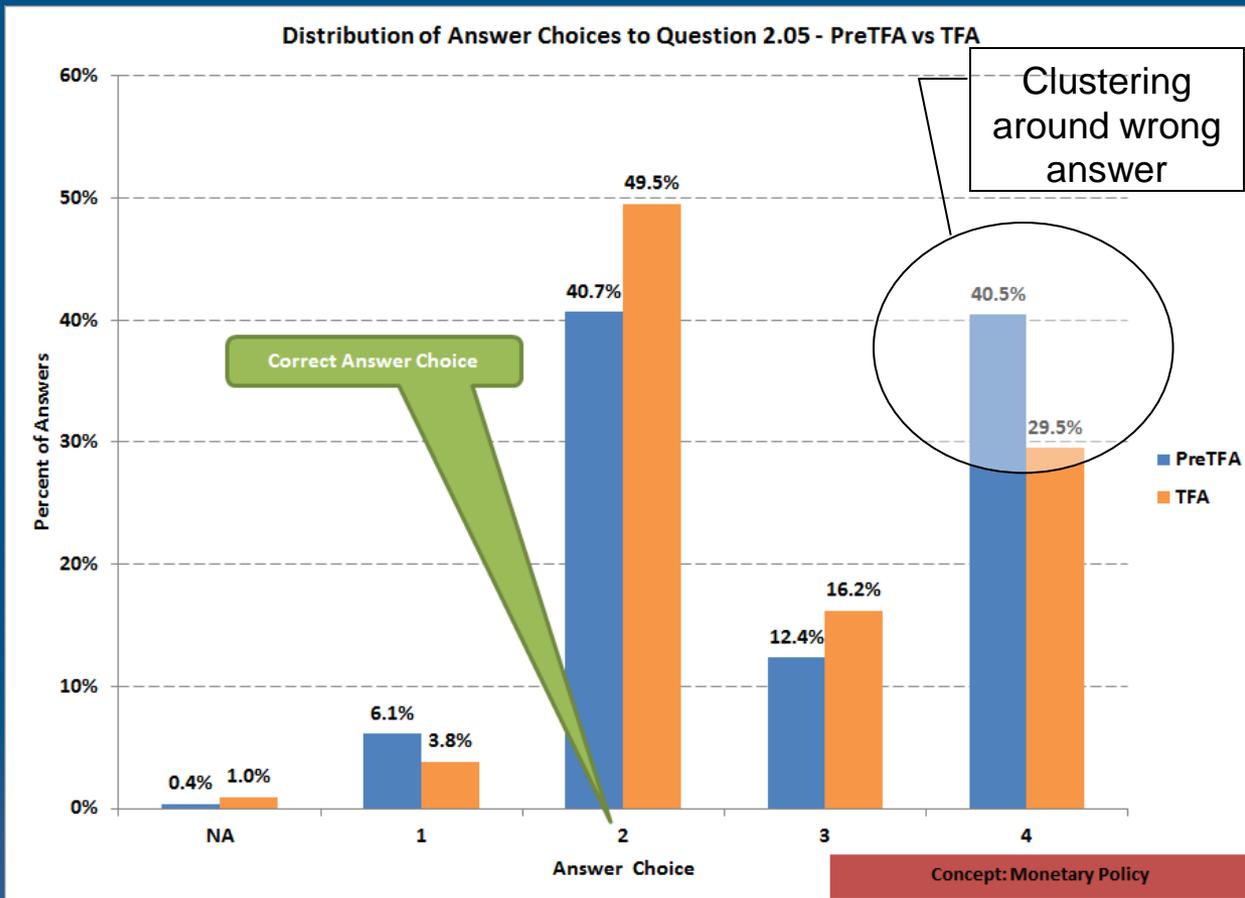
The screenshot shows a software interface for finding equivalent fractions. On the left, the problem is $\frac{5}{12} = \frac{?}{24}$. Below it, a calculation shows $\frac{5}{12} = \frac{5 \times 2}{12 \times 2} = \frac{10}{24}$. On the right, a 'Part-to-Whole Model' consists of two rows of 12 boxes each. The top row is labeled '1 Whole = $\frac{12}{12}$ ' and the bottom row is labeled '1 Whole = $\frac{24}{24}$ '. The bottom row has 10 boxes shaded blue, with a label $\frac{10}{24}$ above them. A 'SKILLOMETER' is positioned in the center, with a yellow arrow pointing up to it. The skillometer lists six skills, each with a progress indicator (a fan shape):

- Calculate equivalent fraction using operations.
- Enter fractional form of one.
- Enter number of smaller pieces in larger piece.
- Find equivalent fraction with Part-to-Whole Model.
- Write equivalent fraction from symbolic statement.
- Write equivalent fraction from verbal statement.

Below the skillometer, a yellow box contains the text: **Every input updates the Skillometer, which closely tracks progress of highly granular skills.**

This adaptive curricular service has produced significant learning gains*

Data Capture and Analysis Improves Curriculum



Two insights that will improve this class:

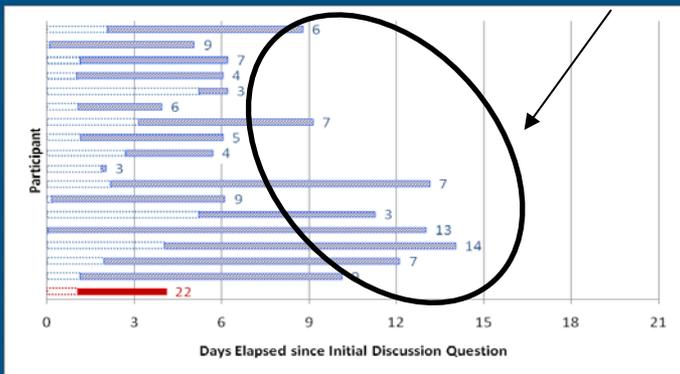
- The learning object is improving number of correct results
- More importantly, the clustering around a specific wrong answer suggests there is a common misconception, which indicates a problem with the question, or the content may be difficult to grasp

Question: Suppose the price level is fixed, the MPC is .5, and the GDP gap is a negative \$100 billion. To achieve full-employment output (exactly), government should

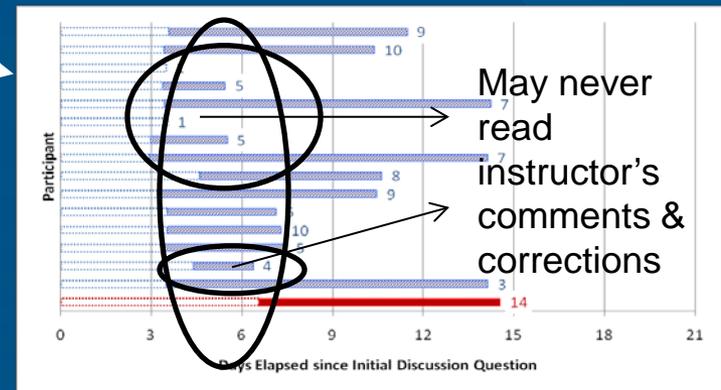
Technology Empowered Just-in-Time Intervention

Early intervention: Instructor comes in early

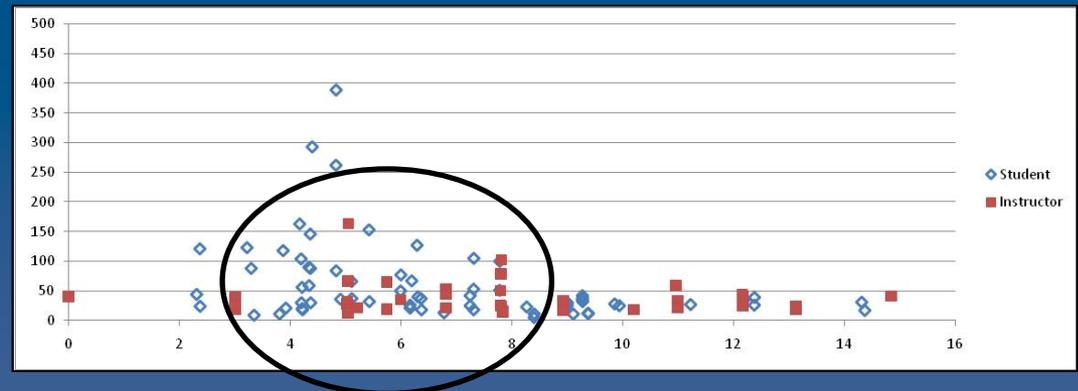
Off-topic, misconceptions



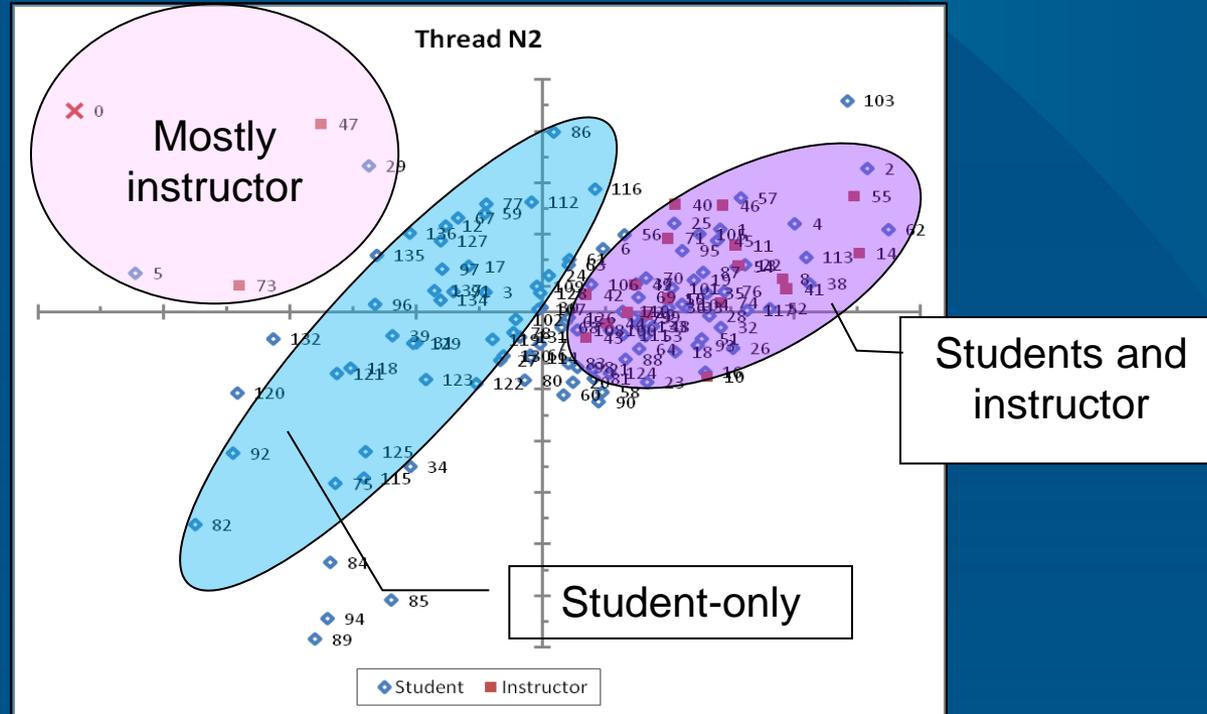
Late intervention: Instructor comes in too late



Goal: Frequent, continual intervention (helps keep students engaged and on task)



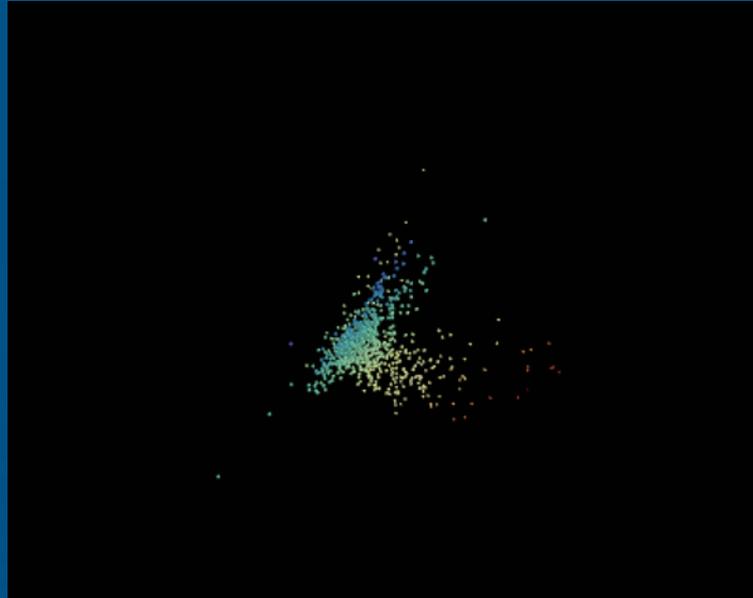
Visualizing unstructured text and social interactions in discussion threads to inform instruction



- Some student-instructor overlap:
 - Similar language, topics
 - Not a guarantee of high-quality interaction, just a window
- Student-only region:
 - Off-topic posts, misconceptions

Source: Ming, N.C., & Baumer, E.P.S. (2011). Using text mining to characterize online discussion facilitation. *Journal of Asynchronous Learning Networks*, 15(2). Research funded by Nexus Research and Policy Center.

Visualizing unstructured text and social interactions in discussion threads to inform instruction



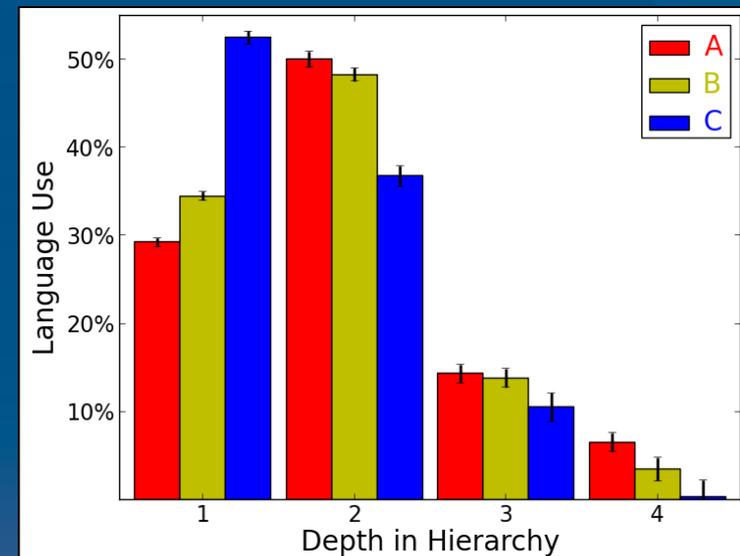
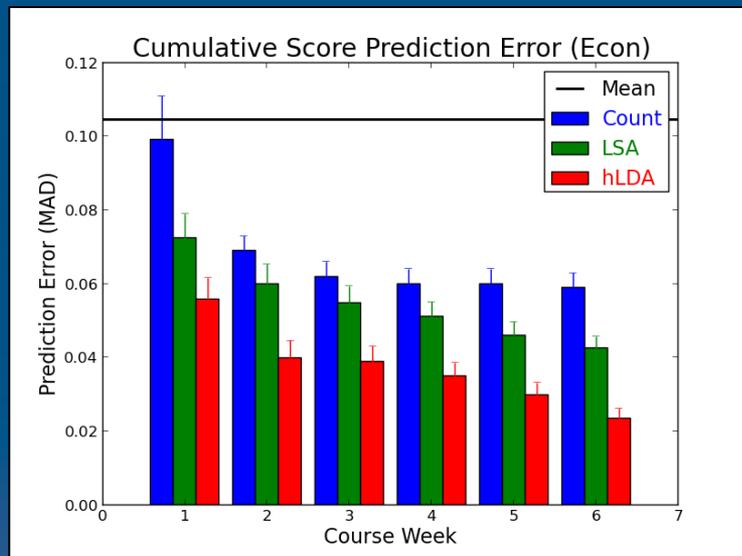
- ▶ ROYGBIV progression of discussion over time
 - ▶ More dispersed (weeks 1, 2)
 - ▶ More tightly clustered (weeks 5, 6)
 - ▶ Converge across weeks and across classes
- ▶ Help instructors recognize (and intervene on) misconceptions, then support correct concepts

Source: From ongoing work by Nexus Research and Policy Center in collaboration with Vivienne Ming, Socos LLC.

Merging unstructured and structured assessment can yield powerful new insights

- ▶ Topic modeling of student writing (from discussion forums) can predict final course grades.

- ▶ Students whose language use reflects more specific topics earn higher grades.



- (1) Ming, N.C., & Ming, V.L. (2012). Predicting student outcomes from unstructured student data. *20th International Conference on User Modeling, Adaptation, and Personalization*. Montreal, Canada.
- (2) Ming, N.C., & Ming, V.L. (2012). Automated predictive assessment from unstructured student writing. *First International Conference on Data Analytics*. Barcelona, Spain.

How does this technology change the way educators interact with information?

- Data-driven decision making
 - Advantages of machine intelligence
 - Advantages of human intelligence
- Combined to guide educators' attention to where their professional expertise is most needed



How does all this change the way learners interact with information?

- Learning is made more active
 - Learning activities when carefully curated minimize wasted attention and effort
 - The processes enable social interactions that facilitate learning
- More opportunities for exploration demand:
 - Broader variety of entry points and investigation paths
 - More checkpoints for course-correcting
 - Greater need for assessment feedback and self-regulation
 - Faster responsiveness to confusion, floundering, misconceptions by students or due to curricular materials

