A computer to understand learning and learning to understand a computer

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Outline

- Learning to understand a computer. Programming in a degree in Health Sciences
  - Web design, gamification and Physical Chemistry
- A computer to (try to) understand learning. BoSCO
 - Browsing: Comparing assignments, semesters and courses
  - Is Homework useful? The story of a futile search. Finding SLO/SDO in metagrades
  - Assess flipping the class: Avoid a control group

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Learning to understand a computer

How important is learning a programming language?

- Problem solving and analytical skills, attention to detail: promotes the development of higher mental functions. It's creative and empowering.
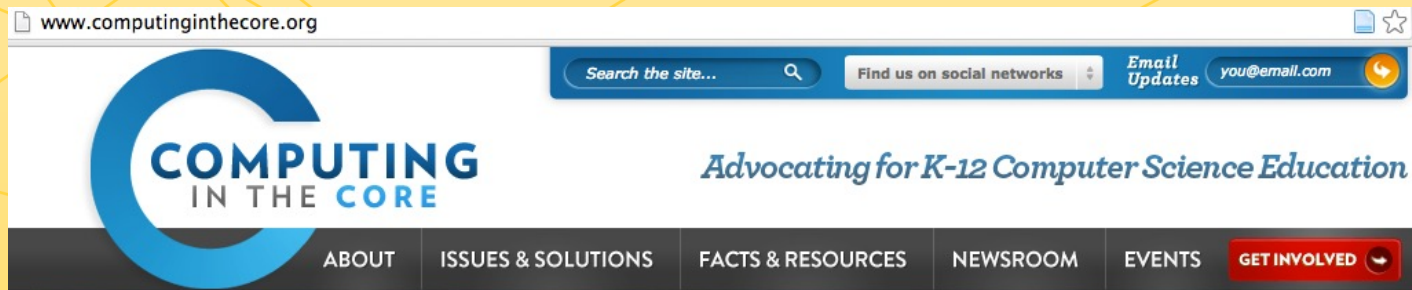
Coding is the closest thing we have to a superpower. Dropbox CEO

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Independent studies: Gamification

How?

→Weekly seminar of 2nd year students: A project-based course
    →Each students ends the semester with at least one
fully functional online activity

→They take online tutorials at home. Bring questions to class
http://www.codecademy.com/

→We only use basic action elements:
    http://jqueryui.com/demos/
    →Click on buttons
    →Drag and drop

Brandon P. Eklund, Joseph W. Inhofer, Jason D. Greenwood, Omar Mohamed, Peter L. Larsen, Xavier Prat-Resina
Students designing online games for active learning sessions in chemistry courses. *Proceedings of EDULEARN14 Conference. 7th-9th July 2014, Barcelona, Spain*

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Independent studies: Gamification

Pick Two To Drag
Show Name

Cations				Combine	Anions			
					H-	O 2-	F-	S 2-
Al+3	NH4+	Ba+2	Ca+2		Cl-	N 3-	Br-	I-
Cr+2	Cr+3	Cu+	Cu+2		AsO4 3-	PO4 3-	AsO3 3-	HPO4 2-
Fe+2	Fe+3	Pb+2	Li+		H2PO4-	SO4 2-	NO3-	HSO4-
Mg+2	Mn+2	Mn+3	Hg2+2		NO2-	S2O3 2-	SO3 2-	ClO4-
Hg+2	NO2+	K+	Ag+		IO3-	ClO3-	BrO3-	ClO2-
Na+	Sr+2	Sn+2	Sn+4		OCl-	OBr-	CO3 2-	CrO4 2-
Zn+2					HCO3-	Cr2O7 2-	CH3COO-	HCOO-
					CN-	NH 2-	OCN-	O2 2-
					SCN-	C2O4 2-	OH-	MnO4-

Isoleucine   Isoleucine   Tyrosine   Lysine   Cysteine   Methionine   Isoleucine   Leucine

Charged

Amine

Hydrophobic

None of These Properties

Independent studies: Gamification

The good:

A win-win situation:
→An opportunity to include programming in any undergraduate major
→We obtain game-like activities targeting specific needs for our courses

The bad:

It is hard to have students learn web design and develop in one semester a platform that meets the quality to be used in class.

The ugly

Still, a very small portion of students are interested in programming

Independent studies: Developing ChemEd X Data

http://chemdata.r.umn.edu

Brandon Eklund and Xavier Prat-Resina
ChemEd X Data: Exposing Students to Open Scientific Data for Higher-Order Thinking and Self-Regulated Learning
J. Chem. Educ., 91(9), 1501-1504, 2014

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Physical Chemistry with "a touch" of python

- Physical Chemistry is a dreaded course for any chemistry major because of its mathematical and abstract approach.

- Thermodynamics is a fundamental science applicable to many areas of science.

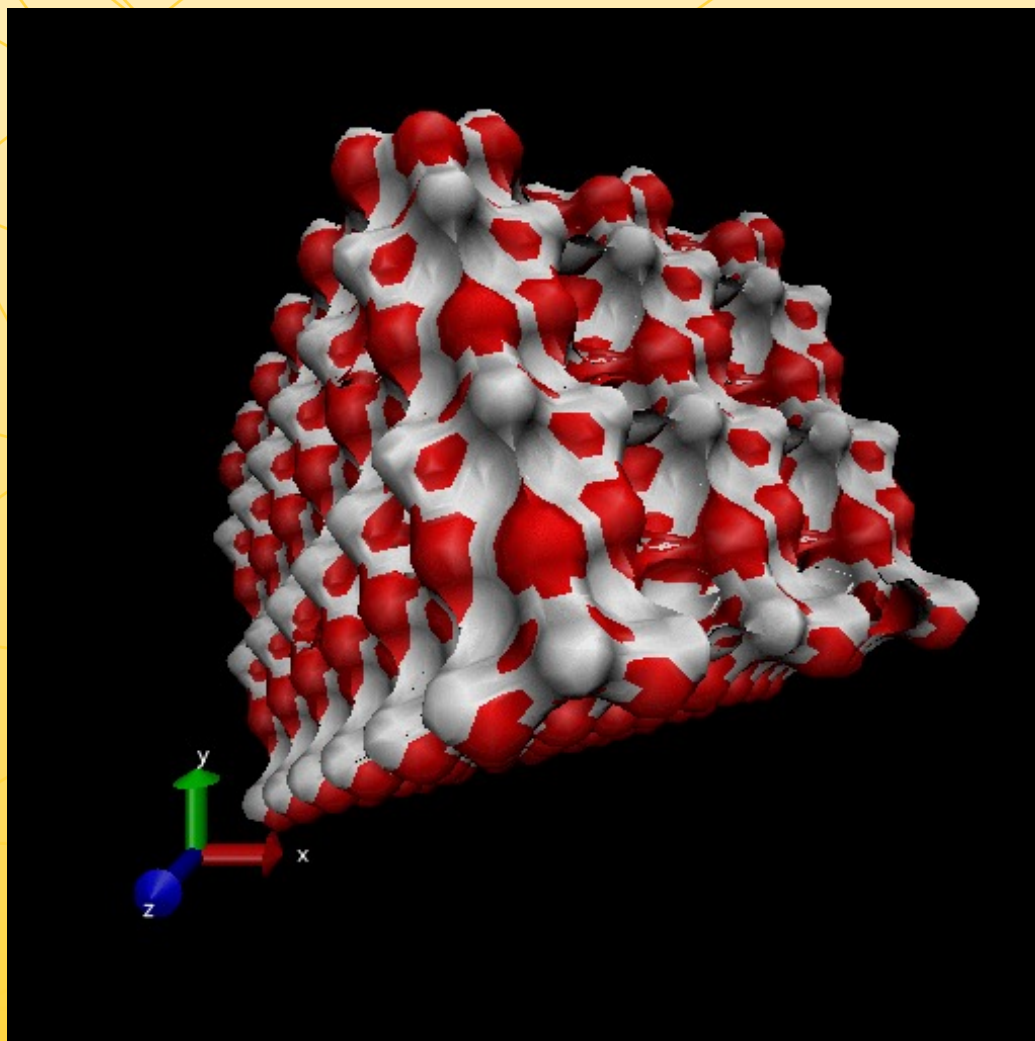- Python helps us manipulate large amounts of data

Xavier Prat-Resina
A new approach to a Physical Chemistry course: Using simulations to learn thermodynamics.
In preparation

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Physical Chemistry with "a touch" of python

How can we measure learning?

- Understanding learning: What kind of evidence do we need?

- Can we quantify the learning experience
  – Validated tools? Control groups?

- Learning analytics: Stating the obvious, spurious correlations or not enough evidence

How can we measure learning?

nature

International weekly journal of science

Home | News & Comment | Research | Careers & Jobs | Current Issue | Archive | Audio & Video | For

Archive > Volume 519 > Issue 7541 > Research Highlights: Social Selection > Article

NATURE | RESEARCH HIGHLIGHTS: SOCIAL SELECTION

Psychology journal bans *P* values

Test for reliability of results 'too easy to pass', say editors.

Chris Woolston

26 February 2015 | Clarified: 09 March 2015

"We believe that the p < .05 bar is too easy to pass and sometimes serves as an excuse for lower quality research,"

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BoSCO: A Browser of Student and Course Objects

- BoSCO: hypothesis generator
  - A radiography or the fingerprint of a curriculum

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Histograms

- 2010-2014 General Chemistry I
- Filter: females vs males

Scatter plots

- Understanding student preparedness in Chemistry
  - ACT-math
  - GPA
  - Misconception chemistry and math survey

Correlation matrix

- Matrix: courses, semesters and assignments
  - Wild search:
    What tasks in the curriculum correlate?

SLICE: Showing Longitudinal Interactions of Course Events

- We use time as the criteria to bundle grades, but in one assignment there may be different questions that assess different skills.

- SLICE Chem Exams: qualitative (A), quantitative(B) and transfer questions(C).

- Metagrades:
  – Number of attempts in a quiz
  – Grade in the first quiz attempt
  – Time taken to take the quiz
  – Chosen questions in a test

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Does homework work?

- Is there any correlation between homework performance and other assigments. Should there be any?

X	Y
Homework grade	Final grade
# of attempts	Exams grade
Grade at first attempt	Type B questions
Time taken	Type C questions

The fact that X and Y are not correlated does not mean that X is useless, rather they address a different skill

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A student report card?

- The final grade is a simplification of what the course is about. A no correlation between homework and final grade makes us think that course performance should be a more complete report rather than a number.

  - Quantitative skills: % (Type B test questions)
  - Follow through commitments: % (Homework and quizzes)
  - Preparedness % (Grade at first attempt on quizzes)
  - Commitment to one task and time efficient % (Time spent in quizzes)
  - Transfer and critical thinking % (Type C and ambiguous questions)

SDO and SLO may be found in "sliced grades" or metagrades rather than regular grades

Flipping the classroom.
Did it help?

- For non discussion-based courses, the course content is available to students at all time.

- For team teaching it sets a standard and gives more freedom to the class instructor.

- But is it helpful for students?

Day 1: Mon. March 23rd

Oxidation states and balancing redox reactions

- lec5 1 chem2333
- 5 - 1 Video 1: Oxidation states and redox reactions
- 5 - 1 Video 2: Reduction and oxidation half-reactions
- 5 - 1 Video 3: Balancing redox reactions
- Pre-class questions 5 - 1
- class5 1 chem2333
- Post-class 5 - 1

Xavier Prat-Resina et al.
"Exploring tools to measure the effectiveness of a flipped classroom in introductory Chemistry courses"
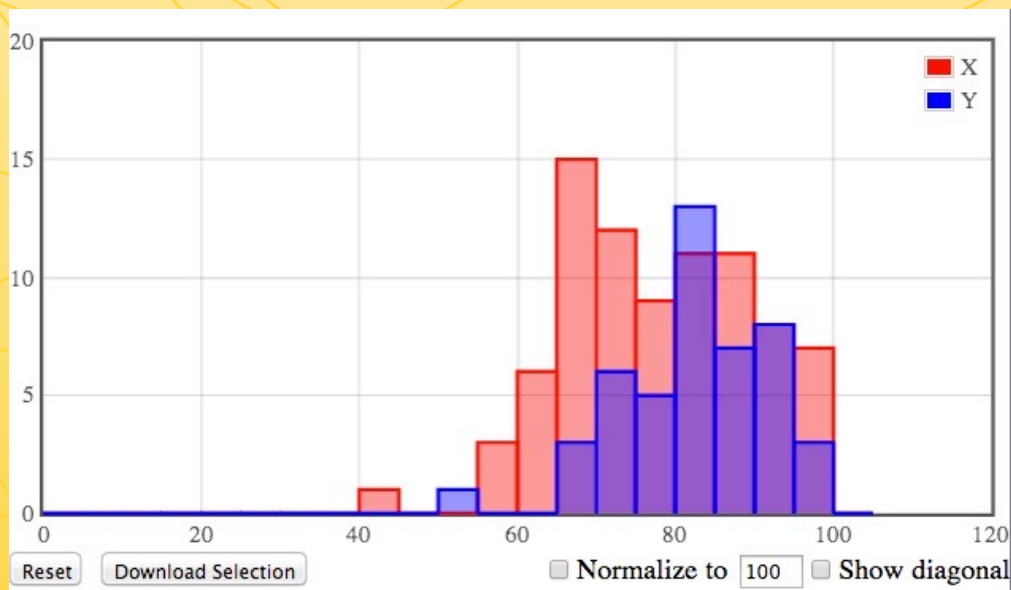*In preparation*

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Measuring curriculum innovations

+curriculum innovation

GenChem 1 – Fall2013 ⟶ GenChem 1 – Fall2014

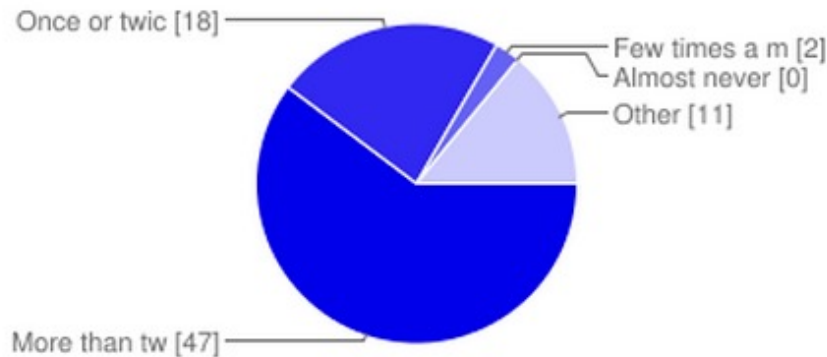different students
different years

Did it
make a difference?

Measuring curriculum innovations

Ask students

How often did you watch the videos that instructors made for this course?

More than twice a week	47	60.3%
Once or twice a week	18	23.1%
Few times a month	2	2.6%
Almost never	0	0%
Other	11	14.1%

Once or twic [18]
Few times a m [2]
Almost never [0]
Other [11]
More than tw [47]

How often did you read the textbook?
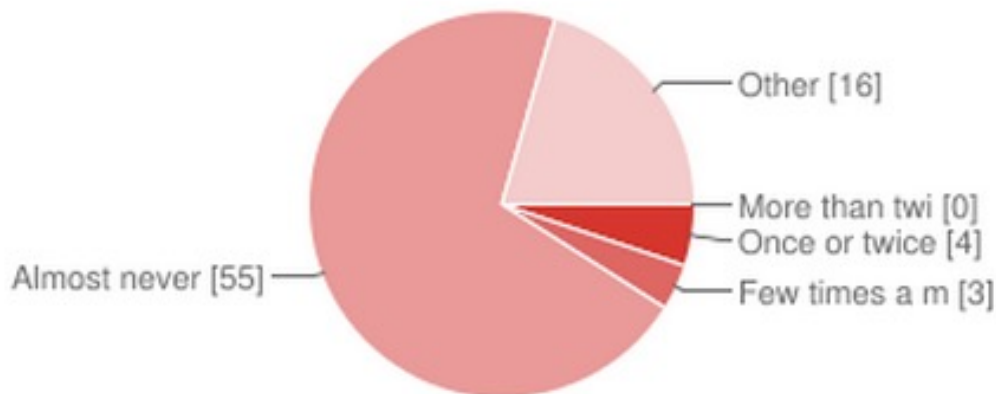
More than twice a week	0	0%
Once or twice a week	4	5.1%
Few times a month	3	3.8%
Almost never	55	70.5%
Other	16	20.5%

Other [16]
More than twi [0]
Once or twice [4]
Few times a m [3]
Almost never [55]

Measuring curriculum innovations

Follow students trail: Youtube Analytics and Moodle Logs
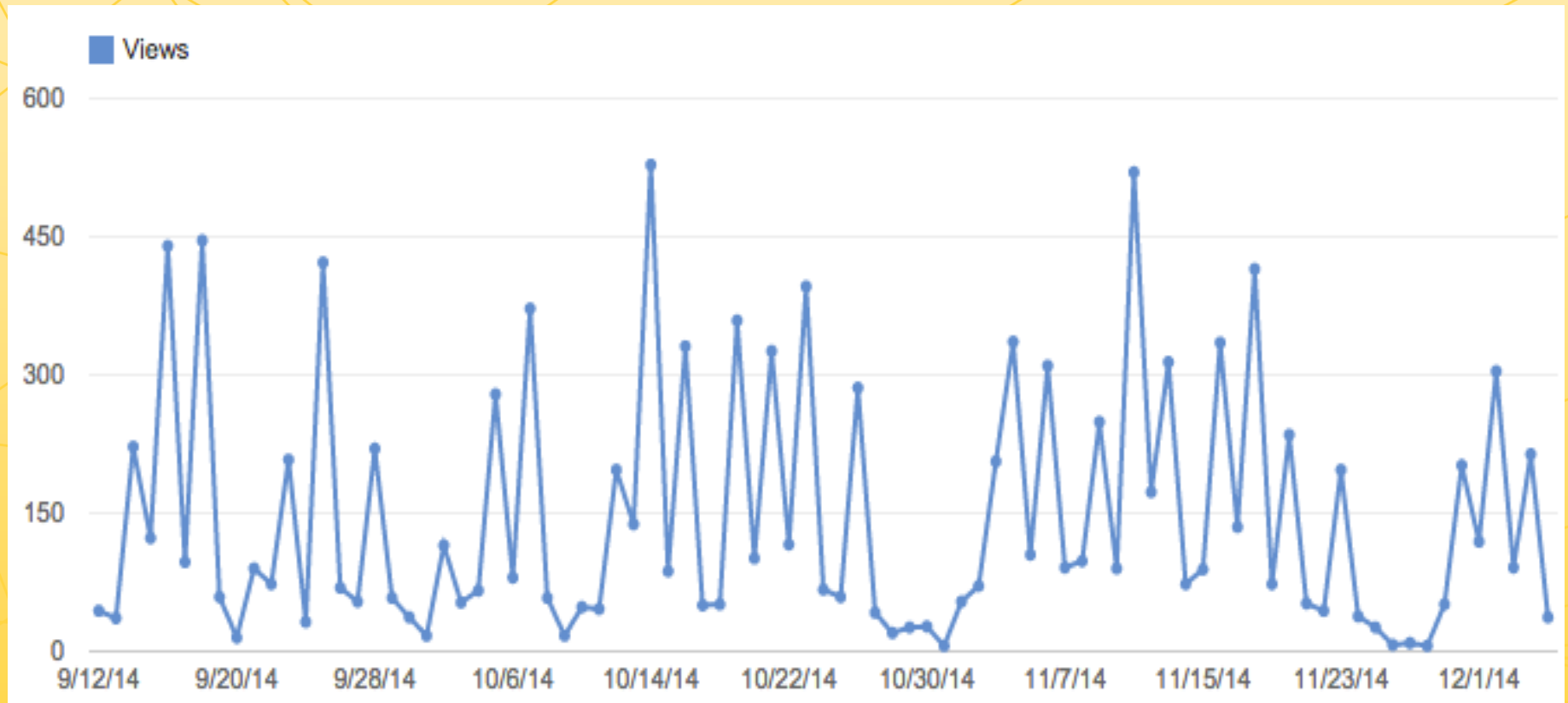
Measuring curriculum innovations

Follow students trail: Youtube Analytics and Moodle Logs

Student views vs student performance. (BoSCO)

Avoiding control groups

Measuring curriculum innovations by comparing student performance with previous course performances. The dendrogram of the curriculum.

Variable Correlation Clusters
core courses.csv using Pearson
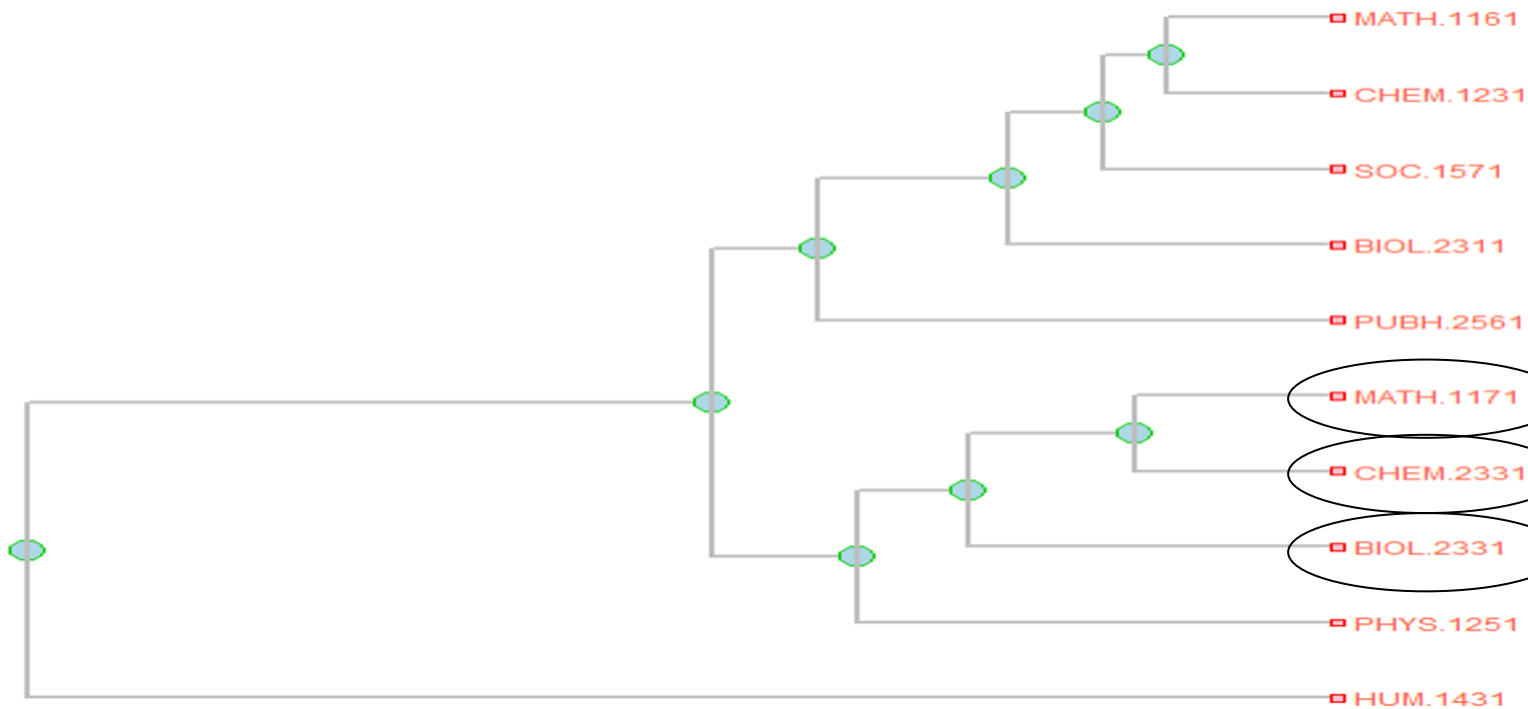
- MATH.1161
- CHEM.1231
- SOC.1571
- BIOL.2311
- PUBH.2561
- MATH.1171 — Calc
- CHEM.2331 — GenChem1
- BIOL.2331 — A&P1
- PHYS.1251
- HUM.1431

Matched pair analysis

A&P 1 – Fall2013 $\longrightarrow$ A&P 1 – Fall2014

paired

Δgrade = 0   (johnny-bio-f13,   mary-bio-f14)

+curriculum innovation

GenChem 1 – Fall2013 $\longrightarrow$ GenChem 1 – Fall2014

Δgrade = + o -   (johnny-chem-f13,   mary-chem-f14)

mean(Δgrade) and student t-test

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Future plans: Enhancing the database

Import student access and tags

Moodle import

Course content

iSEAL-May15

Gradebook

Chemistry Course

Biology Course

Chem-Fall14

Biol-Fall13

Fall14   Fall13

Fall14   Fall13   (...)

Assignment 1 Assignment 2

Assignment 1 Assignment 2

Upload external qualitative or semi-quantitative surveys

Module 1   Module 2

One cannot add an assignment as part of course content (learning object) disconnecting grades and content

Further detail existing on Moodle:
- Individual question grades or itemized rubric
- Time taken
- # attempts

Learn. Obj 1 Learn. Obj 2

Student access
Content tags

Grades

Demographics and pre-college

PeopleSoft

MCAT grades

IRB

Alumni Survey

BoSCO requests

Student development

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a better BoSCO

+Add another set

+Build a bundle

| Course1 Course2 | Semester1 Semester2 | Assignment1 Assignment2 | Question1 Question2 | - Filter / Statistics |

| Course1 Course2 | Semester1 Semester2 | Assignment1 Assignment2 | Question1 Question2 | - Filter / Statistics |

Course/Semester selects students. In that sense, cohort will be part of this menu

Allow multiple selection To bundle within the selection

GPA, GRE, ACT will be listed as assignments

A bundle is a group of grades across courses and/or semesters. You can aggregate as many grades as you wa

If not assignment is selected, the final grad is the default. All grades will be normalized to 100% except GPA, ACT

filter color coded in scatter?

| Histogram | Scatter | Timeline | Correlation matrix |

(default)

Requires two sets and common students

Requires two or more sets across time

Conclusions

- Learning to understand a computer: Please, learn some programming

- A computer to understand learning
  - BoSCO, an hypothesis generator.
  - Some SDO and SLO may be found in metagrades
  - Using an integrated curriculum to measure curriculum innovations.

Thank you