CNS Cyberinfrastructure for Network Science Center

The Information Visualization (IVMOOC): Precision Education for Students from 100+ Countries

Katy Börner and Michael Ginda

Cyberinfrastructure for Network Science Center
School of Informatics and Computing
Indiana University, Bloomington

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CNS Cyberinfrastructure for Network Science Center

Talk Overview

- Precision Education and Learning Analytics
- IVMOOC Course Overview
- Embedding the Visualization Frameworks in Course Design
- Evaluating the IVMOOC
  - Course Administrative Data Analysis and Visualization
  - Student Activity Data
  - User Studies and Experiments
- Future Efforts in Precision Education at IU

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CNS Cyberinfrastructure for Network Science Center — Precision Education and Learning Analytics

Empowering Teachers: How to make sense of the activities of thousands of students? How to guide them?

Empowering Students: How to navigate learning materials and develop successful learning collaborations across disciplines and time zones?

Empowering Researchers: How do people learn? What pedagogy works (in a MOOC) and when?

Empowering MOOC Platform Designers: What technology helps and what hurts?

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IVMOOC 2016

MENU

Register for free: http://ivmooc.cns.iu.edu. Class restarts Jan 10, 2017.

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Information Visualization MOOC Learning Objectives

The course objective is to provide students with overview about the state of the art in information visualization:

- a working knowledge of how to effectively visualize abstract information,
- hands-on experience in the application of this knowledge to specific domains, different tasks and diverse, possibly non-technical users.

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Course Delivery Challenges

Learning Management

- Seamlessly enrolling students from the public with IU students
- Providing students various ways to meet learning objectives
  - Course policies, activities, videos, quizzes, & client projects
- Providing up-to-date and effective course activities, resources, tools;
- Facilitating interaction, collaboration, and communication with students.
  - Client projects, peer reviews

Learning Analytics

- Monitoring student interactions and activity
  - Discussions, homework and quizzes challenges, cheating
- Measuring learning outcomes and performance
- Evaluating quality of content and activities, teaching, technology;
- Predictive analysis and intervention to support students

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Course Infrastructure

The course transition from Google Course Builder to Canvas LMS in 2015 highlighted the need for reliable and reusable infrastructure.

- Course Website & Enrollment systems
  - Working with UITS Canvas team to connect public students to seamlessly create CAS guest accounts, and enrollments in Canvas LMS;
  - Requires and annual updates and re-configuration.
- Canvas Learning Management System
  - Customizable course design that facilitates the reuse, extension, and replication of content delivery.
- Canvas Data Product via Redshift Data Warehouse
  - Current and archival data representing course structure and student activity;
  - Reusable queries, data processing, data analysis scripting and visualizations.
- Course Learning Objects
  - Reusable content that is subject to iterative needs assessments;
    - Videos, wiki-pages, quizzes, homework assignments, exams, study app and client project
  - Up-to-date, accurate, efficient, and useful resources for students.

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Course Structure and Grading

Course Structure

- **Pre/Post Questionnaire**
- **Weeks 1-7:** Theory and Hands-On Training
- **Weeks 8-16:** Real World Client Project

Grading

- Final grade is based on
  - Homework Assignments (10%)
  - Class Participation (10%)
  - Midterm (20%)
  - Final Exam (30%)
  - Client Project (30%)

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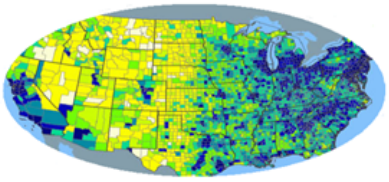
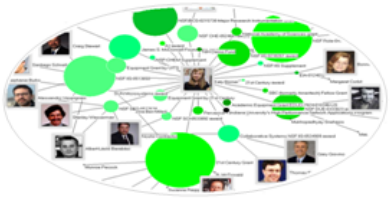
CNS Cyberinfrastructure for Network Science Center — Visualization Design Framework

Macro/Global
Population Level



Meso/Local
Group Level



Micro
Individual Level

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Type of Analysis vs. Level of Analysis

	Micro/Individual (1-100 records)	***Meso/Local (101–10,000 records)***	***Macro/Global (10,000 < records)***
Statistical Analysis/ Profiling	Individual person and their expertise profiles	Larger labs, centers, universities, research domains, or states	All of NSF, all of USA, all of science.
Temporal Analysis (When)	Funding portfolio of one individual	Mapping topic bursts in 20 years of *PNAS*	113 years of physics research
Geospatial Analysis (Where)	Career trajectory of one individual	Mapping a state's intellectual landscape	*PNAS* publications
Topical Analysis (What)	Base knowledge from which one grant draws.	Knowledge flows in chemistry research	VxOrd/Topic maps of NIH funding
Network Analysis (With Whom?)	NSF Co-PI network of one individual	Co-author network	NIH's core competency

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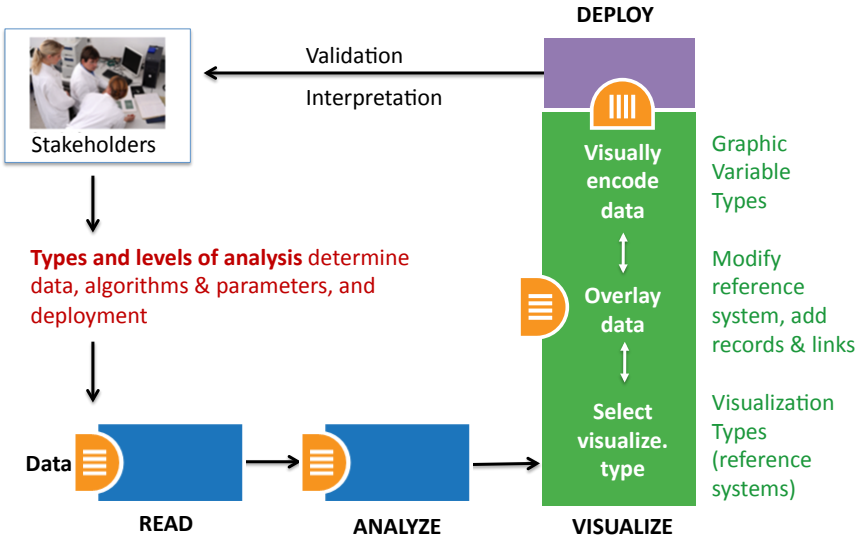
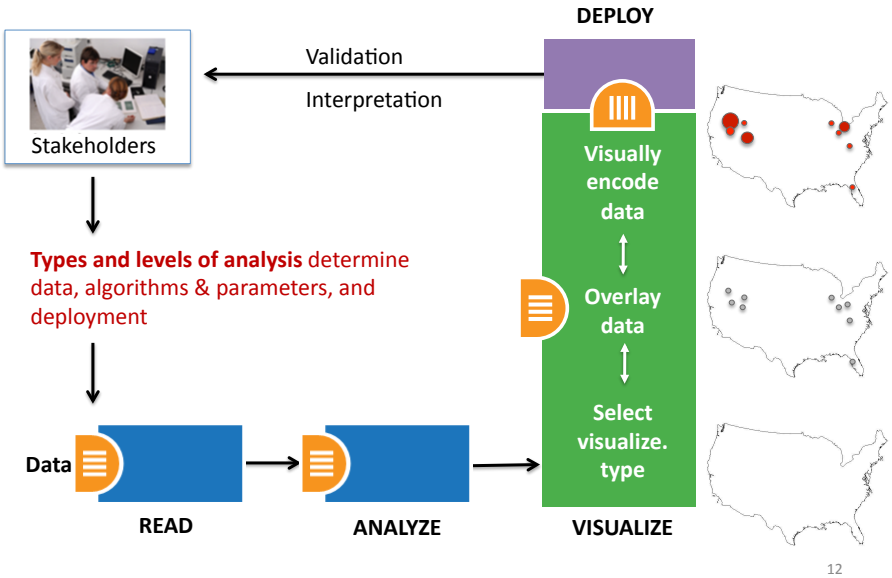
CNS Cyberinfrastructure for Network Science Center — Needs-Driven Workflow Design



CNS Cyberinfrastructure for Network Science Center — Needs-Driven Workflow Design



Evaluating the IVMOOC

CNS uses data generated during the course by students to:

- improve course administration and policies;
- evaluate learning resources and activities;
- design new visualizations for students and instructors.

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Course Evaluation Data Types and Sources

1. Administrative records
   - IVMOOC enrollments – CNS enrollment
   - IU enrollment data – BAR
2. Student activity and performance logs
   - Course grades and submissions – GCB/Canvas LMS front end
   - Course activity logs & discussions – GCB/Canvas Data Product
   - Twitter posts from students – Twitter archive of course hashtag
3. Experimental data
   - Student surveys – Canvas, CNS enrollment
   - User studies and task analysis – administered by CNS
   - A/B testing results administered – administered by CNS

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Course Administration and Policies

Administrative data helps instructors run their courses and monitor student activity to support their learning goals.

Analysis of 2013-2014 student surveys and activity led:

- Creation of two instances of the IVMOOC
  - Self-paced instance rolling admissions, with little direct instructor involvement
  - Concurrent instance for motivated students, with exams, client projects, and instructor/student support
- Updates to homework assignments and study policies
  - Improve collaboration between students, tool troubleshooting and problem solving, increase participation and grades

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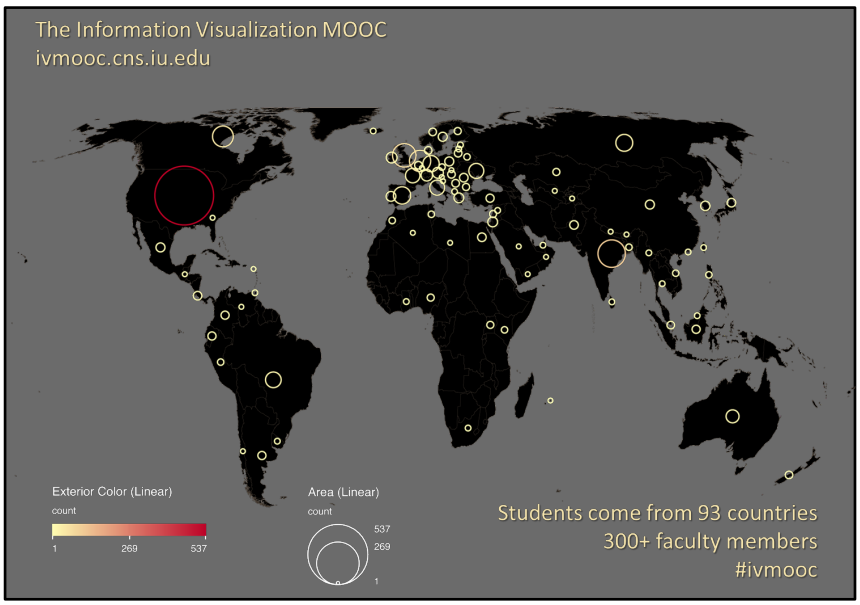
IVMOOC student enrollments map



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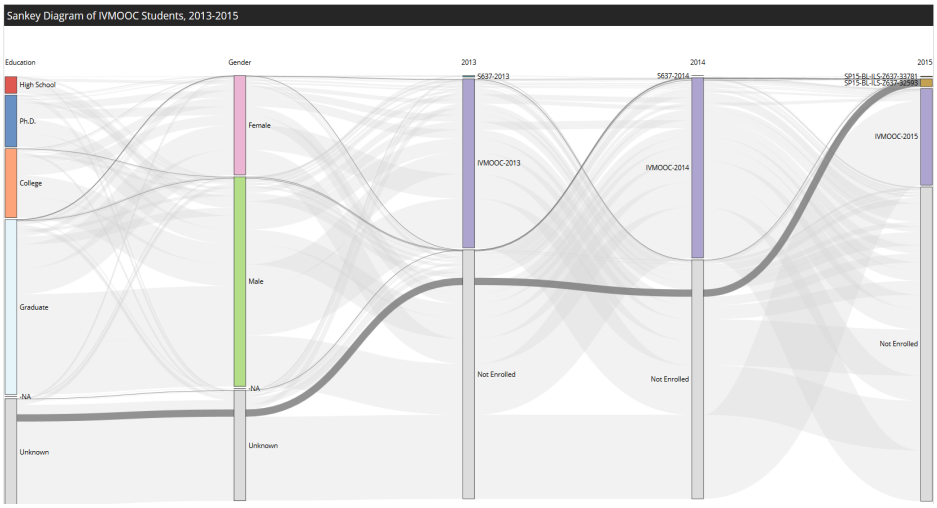
IVMOOC Enrollment Sankey Diagram



Custom interactive visualizations of IVMOOC student enrollments across courses using a Sankey Diagram available at http://demo.cns.iu.edu/client/learning-analytics/sankey.html

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Student Performance and Activity Data

Student submissions, grades, and activity data is collected and analyzed to support instructor tasks and students achieve their learning goals.

- Project selection and guidance
- Course activity periods and study habits
- Course participation and engagement
- Student academic dishonesty

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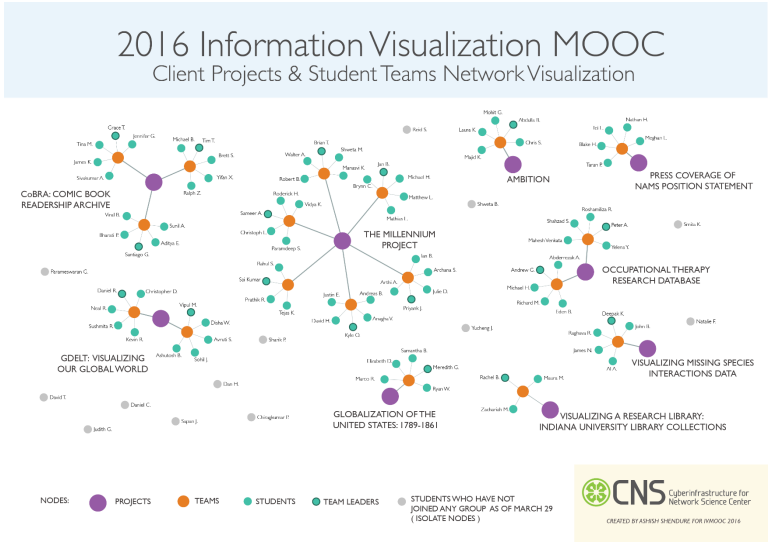
Client Project and Group Affiliations



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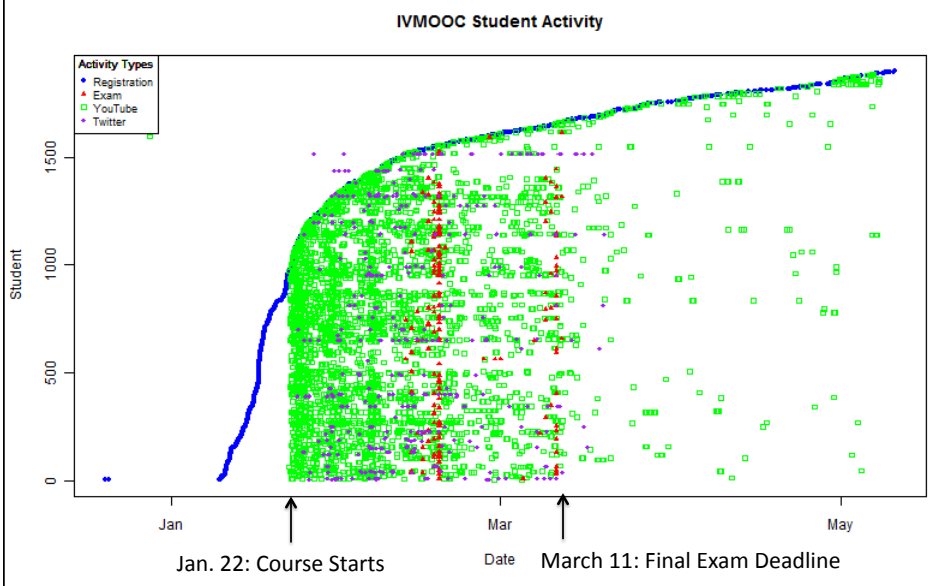
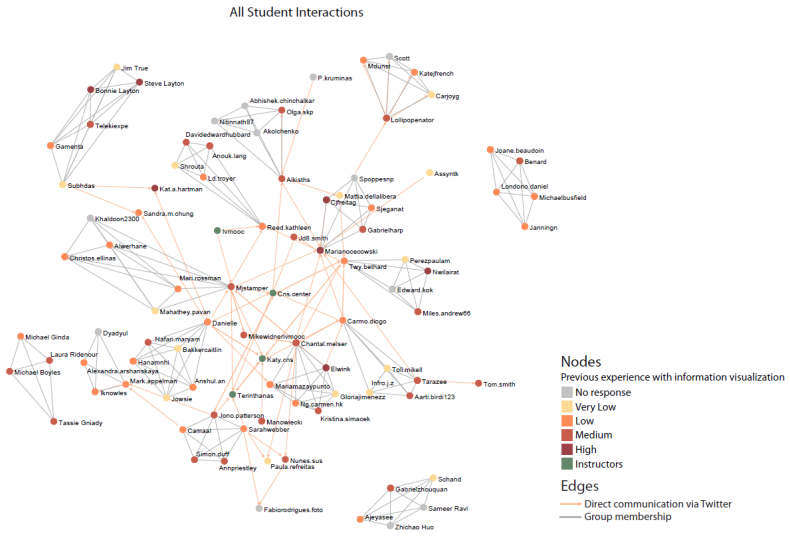
Student Registration and Activity



Student Client Projects: All Interactions



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User Studies and Experimental Data

User studies and experiments provide opportunities to improve

- learning outcomes and the quality of educational resources and activities;
- insight into learner activity, behaviors and academic performance;
- the quality, efficiency, and usability of visualizations used by students and instructors in LMS, tutoring support systems, and course designers and administrators;

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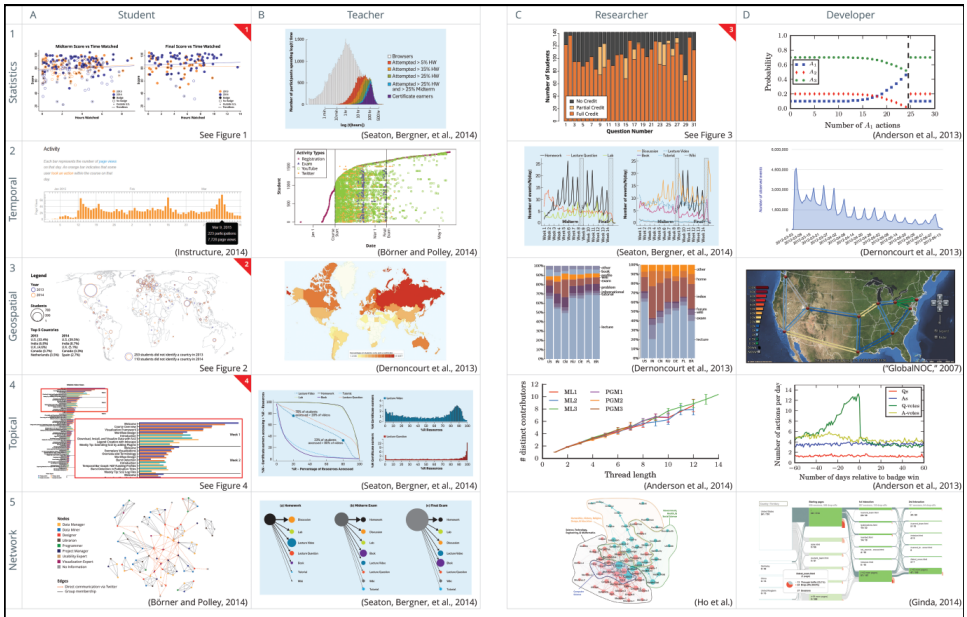

Figure 1: Analysis types vs. user needs.

Emmons, Light, and Börner.
"MOOC Visual Analytics: Empowering Teachers, Students, Researchers, and Developers of Massively Open Online Courses". *Journal of the Association for Information Science and Technology (in press).*

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Learning Analytics

IVMOOC 2015 Student Group Engagement and Scores

	Pre-Course	Week 1	Week 2	Week 3	Week 4	Midterm	Week 5	Week 6	Week 7	Week 8	Week 9	Final	Curr. Score
IVMOOC	26.05%	38.32%	31.32%	29.96%	27.1%	28.34%	31.07%	24.28%	16.86%	18.23%	13.08%	13.41%	20.87%
Z637-29374	33.01%	52.91%	49.89%	59.22%	50.89%	82.56%	65.04%	49.99%	39.59%	61.63%	54.91%	82.25%	82.4%
Z637-32593	25.08%	54.54%	43.58%	50.67%	53.63%	77.67%	65.7%	59.48%	52.19%	65.71%	47.27%	72.59%	75.13%
Z637-33781	29.33%	55.38%	49.26%	62.18%	77.47%	85%	87.4%	69.8%	55.56%	57.6%	45.69%	70.89%	77.94%

IVMOOC 2015 Student Group Engagement for Midterm

	Midterm	Final	Curr. Score	Overall Engagement
Student 198	100%	85.33%	92.67%	30.34%
Student 210	100%	84%	92%	33.91%
Student 242	97.14%	98.67%	97.9%	55.89%
Student 265	95.71%	92%	93.86%	82.64%
Student 216	95.71%	24%	59.86%	34.92%
Student 257	94.29%	98.67%	96.48%	68.25%
Student 264	94.29%	89.33%	91.81%	80.47%
Student 262	94.29%	85.33%	89.81%	79.65%

Legends

Engagement: Inactive — Active — Very Active; 0% 25% 50% 75% 100%

Score: F D C B A; 0% 60% 70% 80% 100%

Description

The heat map visualization is a representation of student engagement (magenta to blue color scale) and performance (red to green color scale) throughout a course. The visualization has two levels. The top level provides an overview of engagement and performance for groups of students, while the bottom level provides a detailed break out of student engagement statistics for individuals with an identified group.

Custom interactive visualizations of IVMOOC student engagement and performance data, explore functionality online at http://goo.gl/TYixCn

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Precision Education at Indiana University

Educational Data Science:
Precision Learning, Teaching, and Leadership
IU Emerging Area of Research Proposal

"We will develop, validate, and optimize models that explain and help predict the impact of different interventions on student success at IU and in life."

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INDIANA UNIVERSITY, KELLEY SCHOOL OF BUSINESS, Bloomington
INDIANA UNIVERSITY, DEPARTMENT OF PSYCHOLOGICAL AND BRAIN SCIENCES, College of Arts and Sciences, Bloomington
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Bloomington Assessment and Research
INDIANA UNIVERSITY, OFFICE OF THE VICE PROVOST FOR UNDERGRADUATE EDUCATION, Bloomington

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The Team

- **Katy Borner**, Victor H. Yngve Distinguished Prof of Information Science, ILS, SOIC
- **Raymond Burke**, E.W. Kelley Prof of Marketing, KSB
- **Robert Goldstone**, Chancellor's Prof, Psychological & Brain Sciences, COAS
- **Dennis Groth**, Vice Provost for Undergraduate Education
- **Daniel Hickey**, Prof, Learning Sciences Program, SoE
- **Michael Kaganovich**, Prof of Economics, Economics, COAS
- **George Rehrey**, PI Consultant with IU's CITL; Director of SOTL
- **Anastasia Morrone**, Prof of Educational Psychology, IUPUI School of Education; Associate Vice President for Learning Technologies, OVPIT; Dean of IT at IUPUI
- **Jennifer Meta Robinson**, Prof of Practice, Anthropology, COAS
- **Linda Shepard**, Senior Assistant Vice-Provost for Undergraduate Education; Director of Bloomington Assessment & Research
- **Timothy F. Slaper**, Indiana Business Research Center, IUB

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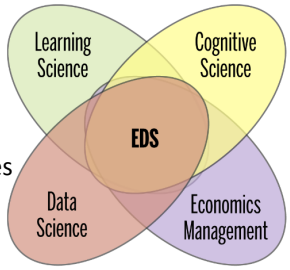
CNS Cyberinfrastructure for Network Science Center — Research Cores

The team will perform cutting-edge, interdisciplinary research in **Educational Data Science (EDS)** at the intersection of four research areas:

- ***Cognitive Science > Classroom Experiments*** investigates the cognitive and social variables, patterns, and leverage points in learning and teaching.
- ***Learning Science > Student Support*** investigates the impact of curricular interventions on student success at IU and in life.
- ***Decision Science: Economics of Higher Education*** investigates the economic value of education across scales—from micro to macro. ***Management/Student Choice Research*** investigates the impact of incentives and educational product offerings on short-term and long-term decision making.
- ***Data Science > Learning Analytics*** performs research on data mining, modelling, and visualization techniques that increase "data (visualization) literacy" and data-driven decision making.

Research Cores



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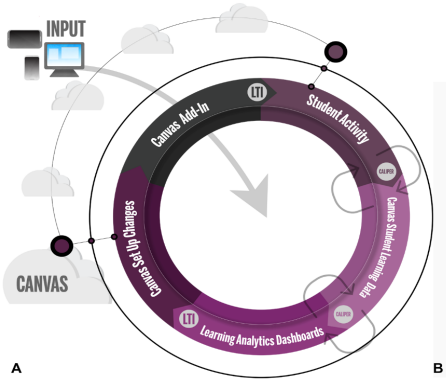
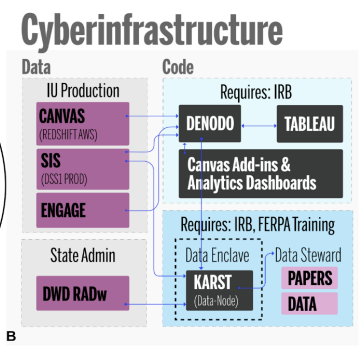
CNS Cyberinfrastructure for Network Science Center — Cyberinfrastructure Core

- Implements novel means to provision sensitive data via secure data enclaves and federated Denodo virtualized databases.
- Develops novel functionality for existing learning management systems (LMS) such as Canvas using LTI and Caliper.
- Uses/extends Tableau to serve actionable dashboards for IU leadership.





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Establishing EDS and Ensuring IU Leadership

Capitalizing on existing IU strengths:

- Student Learning Analytics (SLA) Fellows Program
- Scholarship of Teaching and Learning Program
- Learning Technologies, UITS
- Learning Science Research, PBS, COAS
- Cognitive Science Program, IUB
- Learning Sciences Program, School of Education
- Bloomington Assessment and Research (BAR) office
- Indiana Business Research Center, http://ibrc.indiana.edu
- Decision Support Initiative, http://dsi.iu.edu

Proactive collaborations with other institutions:

- Unizin—11-institution digital learning consortium, http://unizin.org
- Bay View Alliance—8-institution Student Learning Analytics (SLA) initiative

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Visualizations used in the course come from the Places & Spaces: Mapping Science exhibit, online at http://scimaps.org, and from the *Atlas of Science: Visualizing What We Know*, MIT Press (2010).

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CONTACT INFORMATION
katy@indiana.edu |@katycns
mginda@Indiana.edu
http://cns.iu.edu

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