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

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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
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?

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.

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
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**

- **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%)
**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**

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

**Stakeholders**

- Validation
- Interpretation

**Data**

**Types and levels of analysis** determine data, algorithms & parameters, and deployment

**READ**

**ANALYZE**

**VISUALIZE**

**DEPLOY**

- Visually encode data
- Overlay data
- Select visualize type

- Graphic Variable Types
- Modify reference system, add records & links
- Visualization Types (reference systems)

**Graphic Variable Types**

**Variable Types**

**Modify reference system, add records & links**

**Visualization Types** (reference systems)
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.

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
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

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
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;
Figure 1: Analysis types vs. user needs.


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

**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.
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:
- Bay View Alliance—8-institution Student Learning Analytics (SLA) initiative

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THANK YOU

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