Organizational features that influence departments' uptake of student-centered instruction

Case studies from inquiry-based learning (IBL) in college mathematics

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The problem

The problem in STEM education lies less in not knowing what works and more in getting people to use proven techniques.

Fairweather, 2008

Barriers to uptake

Much prior work has focused on individuals:

- Lack of preparation for faculty teaching role
- Lack of knowledge about learning
- Perceptions of student motivation, ability, effort
- Perceived environmental constraints (scheduling, class size, room; coverage, coordinated syllabi)
- Socialization that privileges research (beliefs, knowledge, use of time)
- Reward structures that privilege research
- Anticipated resistance from students & colleagues

e.g. Walczyk, Ramsey & Zha, 2007; Henderson & Dancy

Why departments?

Instructors are embedded in social systems that influence their thinking & decision-making:

- Institution– teaching load, reward structure, advancement criteria
- Department – curriculum structure, teaching assignments, expectations of students, signaling by chairs
- Discipline – culture, norms & beliefs about students & how courses should prepare them

see NAS BOSE white paper by Austin, 2011

The IBL Math Centers

Privately funded "to further develop, study, promote & disseminate the use of IBL approaches in teaching mathematics by fostering IBL activities at … prestigious national universities"

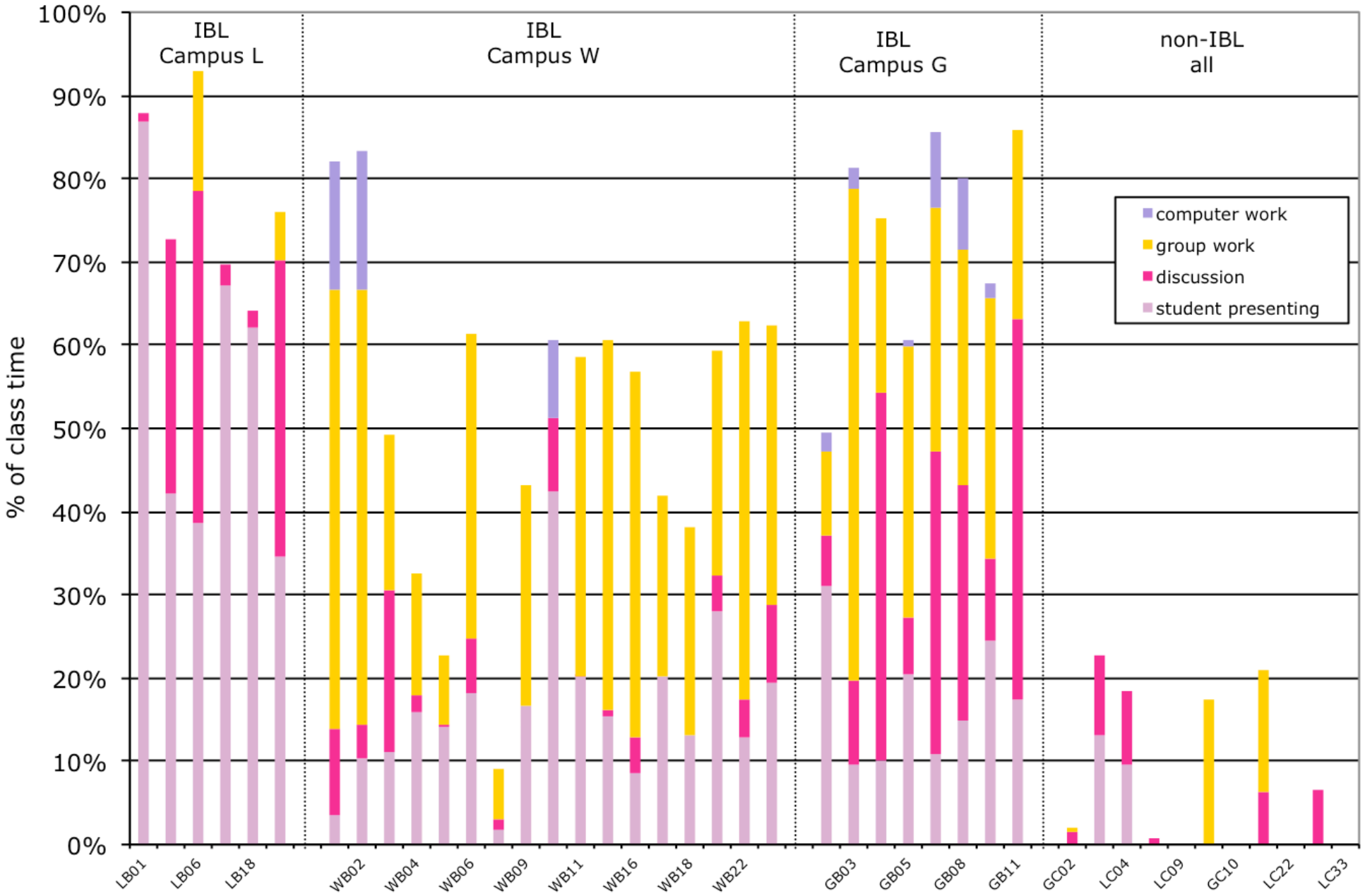
Socratic tradition of R. L. Moore, collegially shared

Shared general approach but diverse in choice of courses & audiences targeted with IBL

Common features of IBL classrooms

- Students solve challenging problems alone or in groups; share solutions; analyze, critique & refine their solutions
- Class time is used for these student-centered activities; students play a leadership role; activities change often
- Course is driven by a carefully built sequence of problems or proofs, rather than a textbook
- Pace is set by students' progress through this sequence
- Course goals usually emphasize thinking skills & communication; content "coverage" is less central
- Instructor serves as "guide on the side" not "sage on the stage"—manager, monitor, summarizer, cheerleader

Instructional practices vary in IBL vs non-IBL classes – and IBL "style" varies by campus



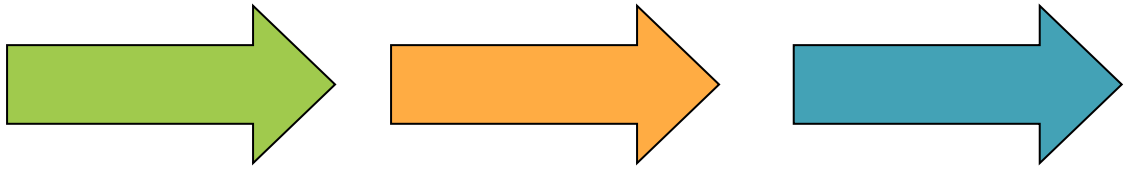
Outcomes of IBL at the Centers

IBL students report higher learning gains on surveys…

- cognitive (math thinking, understanding concepts, applying & teaching math)
- affective (confidence, positive attitude, persistence)
- collaborative gains (working with other students)
- Interviews corroborate the nature of gains reported on surveys
- Preservice teachers make strong gains on MKT assessment after IBL course
- Several subgroups of students benefit in particular

IBL students get grades as good or better in later courses

IBL students' attitudes & beliefs are more supportive of learning following a course (vs. non-IBL students)



Laursen, Hassi, Kogan & Weston (2014); Kogan & Laursen (2014); Laursen (2013); Hassi & Laursen (2015); Laursen, Hassi, & Hough (2015).

Characteristics of the Centers

All Carnegie "very high" research rating

Top 50 math PhD programs (3 in top 15)

UG program full-time 4-year, more selective, lower transfer-in

Mostly white students (1/4 20% Hispanic)

Center leaders are eminent mathematicians (3/4 with track record in K12 or UG ed)

Each has education track record of reformed calculus (3/4) &/or K12 engagement (2/4)

Data sources

Qualitative analysis of 42 interviews with 43 math instructors at 4 IBL Centers

23 faculty

- 3 women, 20 men
- 10 new to IBL, 13 experienced ≥ 1 yr

20 grad TAs in IBL courses

- 9 women, 11 men
- 2nd to 7th year grad students

A variety of historical documents

Descriptive case narratives constructed for each department

Case M

Led by distinguished mathematician & educator; charisma >> collaboration

Stratified dept; main proponents of IBL are nonTT lecturers

- Senior dept members are informed but not participants

IBL focus: 1st & 2nd yr Honors courses; high rigor

- About 50% of ~100 majors/yr get IBL experience
- IBL teaching emphasizes student presentations, discussion
- Student demand led to program expansion
- Strong defense of faculty autonomy, scholarly 'script' creation

High involvement of TAs and hand-picked postdocs

- staged teaching opportunities for TAs
- good collegiality among IBL course teams

K12 outreach efforts brought under IBL umbrella

Resistant to pedagogical language, evaluation & ed research

Case W

Low-key leader– skeptic, savvy manager; collaboration > charisma

Support from chair, dean, UG director & committee

- Growing # of senior faculty involved

IBL targets Honors 1st-years, analysis, pre-service teachers (PSTs)

- ~30% of 140 majors/yr + all K-12 PSTs
- Capitalizes on calculus program, TA preparation
- IBL includes group work, democratic view of benefits

High involvement of a few postdocs via team-teaching

- Clear expectation to pass along materials & lessons learned

Over time IBL has led to improved PST sequence

Most attentive to evaluation & ed research

Theoretical perspectives

Universities are complex systems – so successful change efforts will be non-linear, multi-dimensional

Bolman & Deal's (1991) multi-frame model of organizational analysis: Four "lenses" on organizations

- Structural: rules, policies, procedures, management
- Human resources: demographics, experiences, needs
- Political: resource allocation, formal & informal seats of power
- Symbolic: meaning & culture; rituals, stories, sensemaking

uptake

spread

sustainability

Processes that foster uptake

General IBL practices have spread with adequate fidelity

- collegial & informal mentoring
- some participation in workshops
- support from annual meeting & IBL math practitioners' network

Awareness strategies include

- Inviting senior faculty to observe an IBL course
- Regular dept structures (e.g. UG curriculum committee)
- Lunches & seminars open to all

Processes that (also) spread IBL outward

Active community building

- Lunches, seminars
- Works best when TAs included as instructional partners
- TAs discuss & share practices on their own
- Models: strengthen individual TAs, broaden opportunity

Postdocs & TAs carry away…

- commitment to student-centered teaching
- nuanced toolkits for applying IBL to varied audiences
- ≥ 85% would teach this way again

Processes to sustain IBL within

Sustainability at the IBL Centers is more problematic:

- a distinguished mathematician leads each Center
- a few senior faculty champion IBL courses
- few other senior faculty take part
- little visible effort to transition costs to department

Factors that support spread & sustainability of IBL

	structural	human resource	political	symbolic
+	Formalized course approval thru curriculum committee Engaging senior faculty as steering committee	Prof dev models: workshops, lunches, team teaching, apprenticeships for grad TAs, informal mentoring, national meetings Managing by walking around (builds buy-in, coherence) Strategies to engage senior colleagues' *tolerance & interest*	Use of dept cttees for planning, approval Engaging sr faculty to observe IBL course, evaluate grad TAs Share ed res data with chairs & deans Link to SoE, to gen ed	Sharing program in dept newsletter, website Faculty teaching awards Grads' faculty job success Disseminating via inst'l mini-grant
-	Little overt attention to absorbing course costs outside external $	Transient instructor base Little visible effort to engage senior faculty in *teaching activity*	Some depts inattentive to political work Over-reliance on a single charismatic leader; lack of succession planning	Some depts inattentive to symbolic opportunities

Other features of organizational culture

- Similarity & variation in how IBL was taught
  - *Within* a campus, IBL practice clustered around group work vs formal student presentations
  - Variability *among* the Centers helped shape "big tent" concept of IBL
- Who & what IBL is for
  - Recruiting talented (honors) students into mathematics
  - Helping math majors transition into proof-based courses
  - Teaching non-math majors (esp. PSTs) to think like mathematicians, and to value IBL teaching
- What course content was well suited to IBL
  - Often stated in disciplinary terms but lack of consensus suggests this stems from local curriculum more than disciplinary norms

Can we call this "transformation"?

1. Have teaching & learning practices changed?

   Yes, in some courses

2. Have the changes positively influenced student outcomes?

   Yes, including good outcomes for some groups often under-served in undergraduate mathematics

3. …for enough students to matter?

   20-60% of math majors/yr (total majors 500/yr)

   All pre-service teachers/yr on 2 campuses (~160)

4. Have the changes been sustained? Have they spread?

   Mixed results

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Strategies to foster **uptake & spread** are fairly explicit

- Finding ways to inform & engage colleagues
- Crafting explicit support for instructors
- Drawing in early-career instructors
- Using IBL as focus of teaching community
- Supporting 'leakage' to other courses/units

Strategies to foster **sustainability** are subtle

- Garnering support from those in formal & informal power
- Building alliances with external constituencies
- Leveraging symbolic value, building into dep't self-narrative