Changing K-16 Classroom Practice

The Greater Birmingham Mathematics Partnership (GBMP)

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Greater Birmingham Mathematics Partnership

- National Science Foundation MSP
  - TEAM-MATH
  - PRISM
  - GBMP
    - 9 diverse school systems
    - University of Alabama at Birmingham
    - Birmingham-Southern College
    - Mathematics Education Collaborative

GBMP Components

- Summer Courses for Teachers
- Internal and External Leadership Development
    - Administrators
    - MSTs
    - District Liaisons
- Parent and Community Awareness
- Engineering Application Tasks
- Middle School Mathematics Certification
- New Mathematics Track at UAB

Summer Courses

- Patterns I & II
- Numerical Reasoning
- Geometry
- Probability and Data Analysis
- Extending Algebraic Reasoning I & II

- Designed by Mathematics Education Collaborative
- Each course is 9 days, 54 hours of coursework

Course Characteristics

- Focus on “big” mathematical ideas
- Expandable tasks
- Five representations
- Use of manipulatives
- Group and individual work
- Importance of dissonance to learning process
- Group processing/sharing
- Communication and justification of thinking, both orally and in writing

Sample *Patterns* Task

Step 1 Step 2 Step 3 Step 4

- Build the next two steps in this pattern.
- How many tiles are needed for the 10^{th} step?
- How many tiles are needed for the n^{th} step?

Success of Summer Courses

- CKTM
- Performance Assessment
- Behavioral Checklist
- Portfolios
- RTOP
- Surveys

Changing Instruction at the University Level: What Research Says

- Culture focused on publishing, not teaching
- Lack of awareness/understanding of problem
- STEM faculty unskilled in changing curricula and pedagogy
- Absence of reward and accountability structures
- Large class size and faculty loads
- Lack of sustainability and scalability

Changing Instruction at UAB

- Mathematical Reasoning Track
  - IHE mathematics faculty participation in summer courses
  - Development of mathematics track and degree requirements
  - New middle school teaching certification
  - Revision of current mathematics courses
  - Development of new mathematics courses
  - Changing instructor practice

Changing Instructor Practice at UAB

- MA 313 (modeled after Patterns)
- MA 314 (modeled after Geometry)

- MA 110 (content overlapping with Probability and Data Analysis)

Evaluation Measures

- Students
  - Samples of problem sets and portfolios
  - Focus groups
  - Interviews
  - Surveys
- IHE Faculty
  - Classroom observations
  - Syllabi and assignments
  - Focus groups
  - Interviews

IHE Observations

RTOP Categories (maximum score on each subscale is 20)	Traditional UAB Courses (n=7) Median (Range)	Revised UAB Courses (n=5) Median (Range)
Lesson Design/Implementation	1 (0 - 3)	14 (11-15)
Propositional Knowledge	3 (3 - 6)	11 (10-12)
Procedural Knowledge	2 (0 - 6)	14 (14)
Communicative Interaction	1 (0 - 3)	13 (10-15)
Student/Teacher Relationships	2 (0 - 7)	14 (12-14)

Repeated Observations

RTOP Categories (maximum score on each subscale is 20)	Baseline	Revised
Lesson Design/Implementation	3	11
Propositional Knowledge	6	11
Procedural Knowledge	6	14
Communicative Interaction	3	13
Student/Teacher Relationships	7	14

Repeated Observations

RTOP Categories (maximum score on each subscale is 20)	MA 313		MA 314	
	Time 1	Time 2	Time 1	Time 2
Lesson Design/Implementation	14	18	15	18
Propositional Knowledge	10	17	12	17
Procedural Knowledge	14	18	14	18
Communicative Interaction	13	16	15	17
Student/Teacher Relationships	14	17	14	17

Finite Mathematics MA 110

- Core curriculum course for general studies
- Recently redesigned to include computer-assisted instruction
  - PROS
    - Actively engaged with material
    - More time spent on task
    - On-demand help in lab
  - CONS
    - Algorithmic learning
    - Emphasis on memorization
    - Computation rather than thought
    - Tenuous connection with QL

MA 110 Study

- All students exposed to same computer assisted lab instruction
- Three different class meeting formats
  - Lecture on up-coming material
  - Lecture on up-coming material and weekly in-class short quiz
  - Group work with no prior instruction
- Random assignment of students to class formats

MA 110 Measures

- Content pre-test and post-test
  - Problem identification
  - Problem-solving
  - Explanation
- Mathematics self-efficacy survey
- Course grades
- Focus groups at end of semester
- Longitudinal post-test (one year)

Benefits of Inquiry-Based Instruction: What Faculty Say

- Focus on exploration instead of lecture
- Building of self-esteem and productive disposition in students
- Students have deeper understanding of content
- Students show improved ability to communicate mathematical thinking
- Students show improved problem-solving abilities

Challenges of Inquiry-Based Instruction: What Faculty Say

- Buy-in from other faculty members
- Outside pressure to cover breadth of content
- Grading and accountability issues
- Students' anxiety and resistance
- Perception of lack of rigor
- Class duration
- Class size
- Logistical issues (space, storage)
- Statewide articulation agreement
- Tasks losing usefulness over time

What Students Say

- After one course
  - Frustration of not knowing whether answers are correct
  - Lack of structure and purpose
  - Lack of clarity about grading
  - Required to “teach yourself”
  - Group work not always effective
  - Okay sometimes, but shouldn’t be only method

What Students Say

- After two courses:
  - Learned much more about mathematics
  - In some ways more difficult than traditional (have to think more, do more active work)
  - In some ways easier than traditional (no memorizing or cramming, no longer mysterious)
  - More rewarding to find answers yourself
  - More confident about mathematics ability

  - Lingering concerns about grading
  - Group work still a problem for some

Emerging Ideas

- Immersion experience is critical
- Characteristics of students impact effectiveness
- Instructors and students get better at inquiry-based instruction over time
- Must have supportive environment for inquiry based instruction to be successful for students and instructors

Emerging Questions

- What makes some change, others not?
- Do students actually learn more this way?
- How is nature of learning different?
- What will be the effect in the classroom?
- What will it take to make it happen systemically or institutionally instead of individually?