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

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

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

<table>
<thead>
<tr>
<th>RTOP Categories</th>
<th>Baseline</th>
<th>Revised</th>
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<tbody>
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<td>Lesson Design/Implementation</td>
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Repeated Observations

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<tr>
<td>(maximum score on each subscale is 20)</td>
<td>Time 1</td>
<td>Time 2</td>
</tr>
<tr>
<td>Lesson Design/Implementation</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Propositional Knowledge</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Procedural Knowledge</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>Communicative Interaction</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>Student/Teacher Relationships</td>
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<td>17</td>
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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

<table>
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<tr>
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<tbody>
<tr>
<td>Content pre-test and post-test</td>
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<tr>
<td>- Problem identification</td>
</tr>
<tr>
<td>- Problem-solving</td>
</tr>
<tr>
<td>- Explanation</td>
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<tr>
<td>Mathematics self-efficacy survey</td>
</tr>
<tr>
<td>Course grades</td>
</tr>
<tr>
<td>Focus groups at end of semester</td>
</tr>
<tr>
<td>Longitudinal post-test (one year)</td>
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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?