Who are we teaching and how do we teach them?

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Greater Birmingham Mathematics Partnership
Motivating Questions

- How should pre-calculus (service/general education) courses be taught?
- What is the teaching role that one should model for future elementary and secondary teachers?
- How do we encourage reflection upon the professor’s role as a teacher of teachers?
The Big Picture

- “The Wu Li master does not teach but the student learns”
  [Gary Zukav, The Dancing Wu Li Masters]

- Challenge the traditional paradigm of the sagacious mathematician delivering knowledge to the eager (or not so eager) student.
Topic Outline

- Part 1: Recent influences on Math Pedagogy at UAB
  - Greater Birmingham Mathematics Partnership (NSF Math/Science Partnership)
  - Quantitative Literacy (QL)
  - Course Reform: Active vs Passive Learning
- Part 2: Finite Mathematics (MA 110) at UAB
  - Wiliam Bond
Greater Birmingham Mathematics Partnership

- Partners in GBMP
  - 9 Birmingham area school districts
  - University of Alabama at Birmingham
  - Birmingham Southern College
  - Mathematics Education Collaborative (WA)
- Summer courses for in-service teachers
- Internal and external leadership development
- Parent and community awareness
- Course revision in higher education
  - Middle school mathematics certification
  - New mathematics major track at UAB
Challenging Courses and Curriculum (CCC)

- Deepening knowledge of important mathematical ideas
- Productive disposition
- Inquiry and reflection
- Communication
Quantitative Literacy at UAB

- UAB SACS Re-Accreditation 2004
- Quality Enhancement Plan (QEP)
- Shift of General Education Focus
  - From: Checklist of courses
  - To: Shared Vision for a UAB Graduate
- Areas of QEP Emphasis in Shared Vision
  - Communication through writing
  - Ethics and civic responsibility
  - Quantitative literacy (QL)
Course Reform: Active vs Passive Learning

- How to turn passive learners into active learners?
  - Engage them
  - Keep them motivated
  - Pay them with grades

- First Step
  - Reduce didactic instruction
  - Adopt computer-assisted instruction
  - Variety of problems (on the computer)
GBMP Summer Courses

- Longitudinal data on teachers’ mathematics content knowledge
  - CKTM is a (algebra) teaching/content knowledge test largely based on Deborah Ball’s work

- Analysis of middle school student test data
  - SAT 10

Center for Educational Accountability (CEA) at UAB
Rachel Cochran, chief GBMP evaluator
CKTM Longitudinal Data

- n=21 teachers
- **Pre** = day before Patterns (1\textsuperscript{st} course)
- **Post** = last day of Patterns
- **Long** = at least one year after Patterns and last day of second or third course

**Pre-Post**
- Median increase: + 3 points
- Range of increase: -2 to +10
- IQR: +2 to +5
- Two decreased, two stayed the same, rest went up
CKTM Longitudinal Data

Post-Long
- Median increase: +2 points
- Range of increase: -3 to +5
- IQR: +0 to +3
- Three decreased, five stayed the same, rest went up

Pre-Long
- Median increase: +5 points
- Range of increase: -2 to +10
- IQR: +2 to +7
- One decreased, rest went up
Changes in GBMP Schools by Implementation Level

- 3 systems for which SAT-10 scores available
  - High Implementing Schools
  - Medium Implementing Schools
  - Low Implementing Schools

- Changes in students’ scores 2006\2007 compared

- Statistically significant interaction
Student Data

GRADE 4 TO GRADE 5

SAT 10 NORMAL CURVE EQUIVALENTS

GBMP SCHOOLS
- LOW IMPLEMENTATION
- MED IMPLEMENTATION
- HIGH IMPLEMENTATION

Estimated Marginal Means

YEAR

2006 2007
Student Data

System B: 4th to 5th GR Schools

SAT 10 Scores

YEAR

Estimated Marginal Means

GBMP

Low
Moderate
High
Finite Mathematics
MA 110 at UAB

- Base: Computer assisted instruction
- Power:
  - Why value group work?
  - What comes from frustration?
  - Comparative Study of Pedagogy Underway
Active Learning – Computer: All Pre-Calculus Classes

- 1/3: One class meeting per week
  - What do we do with this class meeting?
- 2/3: Assigned and self-selected time in Mathematics Learning Lab (MLL)
- Assessment
  - Attendance (class & lab) (14-28%)
  - 20-30 homework problems per week (7-10%)
  - Weekly quiz (7-10%)
  - Four tests per semester (and final) (60-70%)
- Variety of assistance on computer and in lab
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
Group Work Class Format in MA 110

- Groups of three to four people are selected at random at the beginning of each class.
- Each group is given the same in-class problem.
- Group of Four Rules
  - Groups write up a solution and explanation.
  - Groups volunteer to share their solution and reasoning with the class.
Group of Four Rules

- Each member takes responsibility for his/her own learning
- Each member is willing to help every other member who asks for help
- Groups may ask the teacher for help only when all members have the same question
- There is always a further challenge!

Mathematics Education Collaborative
Why Value Group Work?

- Addresses cons of computer assisted instruction
  - Students construct their own mathematical understanding
  - Emphasis on problem solving, communication, and justification
  - Addresses UAB QL goals

- Ideas inspired by GBMP summer courses
  - Focus on “big” mathematical ideas
  - Expandable tasks
  - Importance of frustration to learning process
What comes from Frustration?

- Building of self-esteem and productive disposition
- Deeper understanding of content
- Long term retention
- Improved ability to communicate mathematical thinking
- Improved problem-solving abilities

We see all this in the GBMP summer courses for teachers.
Comparative Study, Fall 2008: MA 110 Class Formats

- 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
Why a Comparative Study?

- Previous data based on
  - GBMP summer courses for teachers
  - UAB mathematics courses for elementary teachers
  - No computer assisted instruction component
- Will the combined approach work for general studies students?
Comparative Study: Measurements

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

- **Hypothesis 1**: Classes will have similar grades regardless of class meeting format
- **Hypothesis 2**: Group work class will have improved mathematics self-efficacy
- **Hypothesis 3**: Group work class will have improved mathematics communication skills
- **Hypothesis 4**: General studies students will benefit from inquiry-based instruction in mathematics
Summary of Results

• Watch this space
Where to Get More Information

- http://www.math.uab.edu/GBMP/
- http://gbmp.mspnet.org/index.cfm/