## Math in the Middle Institute Partnership

## Principal Investigators

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(Funding began August 1, 2004)

## $M^{2}$ Goal

Invest in high-quality teachers

* To improve K-12 student achievement in mathematics and to significantly reduce achievement gaps in the mathematical performance of diverse student populations.


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## M ${ }^{2}$ Partnership Vision

- Create and sustain a University, Educational Service Unit (ESU), Local School District partnership
- Educate and support teams of outstanding middle level (Grades $5-8$ ) mathematics teachers who will become intellectual leaders in their schools, districts, and ESUs.
- Provide evidence-based contributions to research on learning, teaching, and professional development.
- Place a special focus on rural teachers, schools, and districts.


## M ${ }^{2}$ Partnerships People and Organizations

- 15 Educational Service Units
- 47 Local School Districts
- 67 Schools
- 96 Teachers (3 cohorts of teachers to date)
- 27 teachers earned their Masters Degree in May or August 2006
- Hundreds of teachers and


Yellow denotes year 1 ESU partners
Blue denotes additional ESU partners joining in year 2
Pink signifies ESU partners joining in year 3 .
Green indicates ESU partners joining in year 4 students will benefit from this grant

## M² Major Components

- The $\mathbf{M}^{2}$ Institute, a multi-year ( $25-m o n t h$ ) institute that offers participants a coherent program of study to deepen their mathematical and pedagogical knowledge for teaching and to develop their leadership skills;
- Mathematics learning teams, led by $\mathrm{M}^{2}$ teachers and supported by school administrators and university faculty, which develop collegiality, help teachers align their teaching with state standards, and assist teachers in examining their instructional and assessment practices; and
- A research initiative that will transform the $\mathrm{M}^{2}$ Institute and the $\mathrm{M}^{2}$ mathematics learning teams into laboratories for educational improvement and innovation.

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# Math in the Middle Institute Partnership 

$\mathrm{M}^{2}$ courses focus on these objectives:

- enhancing mathematical knowledge
- enabling teachers to transfer mathematics they have learned into their classrooms
- leadership development and
- action research


# Math in the Middle Institute Design 

|  | Summer |  | Fall | Spring |
| :--- | :--- | :--- | :--- | :--- |
| Yr 1 | M800T | Teac800 \& M802T | Stat892 | M804T |
| Yr 2 | M806T | Teac801 \& M905T | Teac888 | M807T |
| Yr 3 | M808T | Teac889/M809T <br> and the Masters Exam |  |  |
|  |  |  |  |  |

- A 25-month, 36-hour graduate program.

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## M ${ }^{2}$ Summer Institute

- Combination of 1 week and 2 week classes.
- Teachers are in class from 8:00 a.m. - 5:00 p.m.
- 32-35 teachers -5 instructors in class at one time.
- Substantial homework each night.
- Substantial End-of-Course problem set
- Purpose - long term retention of knowledge gained.
- Presentation of solutions/celebration of success at start of next class.



## $\mathbf{M}^{2}$ Academic Year Courses

- Two-day (8:00-5:00) on-campus class session.
- Course completed as an on-line, distance education course using Blackboard and Breeze.
- Major problem sets
- Professional Writings
- Learning and Teaching Projects
- End-of-Course problem set
- Substantial support available for teachers


## M ${ }^{2}$ Institute Courses

- Eight new mathematics and statistics courses designed for middle level teachers (Grades 5 - 8) including:
- Mathematics as a Second Language
- Experimentation, Conjecture and Reasoning
- Number Theory and Cryptology for Middle Level Teachers
- Using Mathematics to Understand our World
- Special sections of three pedagogical courses:
- Inquiry into Teaching and Learning
- Curriculum Inquiry
- Teacher as Scholarly Practitioner
- An integrated capstone course:
- Masters Seminar/Integrating the Learning and Teaching of Mathematics Mathenatics


## Math 800T - Mathematics as a Second Language

- The "text" was written by Kenneth and Herbert Gross of the Vermont Mathematics Initiative.
- Ken helped us "kick off" our first weekend.
- Our Innovations (i.e. additions)
- Habits of Mind problems
- Professional Writings
- Learning and Teaching Project


## $\mathrm{M}^{2}$ Innovations

## "Habits of Mind" Problems

A person with the habits of mind of a mathematical thinker can use their knowledge to make conjectures, to reason, and to solve problems. Their use of mathematics is marked by great flexibility of thinking together with the strong belief that precise definitions are important. They use both direct and indirect arguments and make connections between the problem being considered and their mathematical knowledge. When presented with a problem to solve, they will assess the problem, collect appropriate information, find pathways to the answer, and be able to explain that answer clearly to others.

While an effective mathematical toolbox certainly includes algorithms, a person with well developed habits of mind knows both why algorithms work and under what circumstances an algorithm will be most effective.

## $\mathrm{M}^{2}$ Innovations "Habits of Mind" Problems

Mathematical habits of mind are also marked by ease of calculation and estimation as well as persistence in pursuing solutions to problems. A person with well developed habits of mind has a disposition to analyze situations as well as the selfefficacy to believe that he or she can make progress toward a solution.

This definition was built with help from Mark Driscoll's book, Fostering Algebraic Thinking: A guide for teachers grades 6-10.

## $\mathrm{M}^{2}$ Innovations "Habits of Mind" Problems

The Triangle Game: (Paul Sally, U. Chicago) Consider an equilateral triangle with points located at each vertex and at each midpoint of a side. The problem uses the set of numbers $\{1,2,3,4,5,6\}$. Find a way to put one of the numbers on each point so that the sum of the numbers along any side is equal to the sum of the numbers along each of the two other sides. (Call this a Side Sum.)

- Is it possible to have two different Side Sums?
- What Side Sums are possible?
- How can you generalize this game?


## M ${ }^{2}$ Innovations

## Professional Writings

## What do Math Teachers Need to Be?

Read "What do Math Teachers Need to Be?" by Herb Clemens, a mathematics professor at The Ohio State University. Where does your own practice of teaching mathematics stand in relationship to what Clemens says mathematics teachers need to be: unafraid, reverent, humble, opportunistic, versatile, and in control of their math. If Clemens came to your classroom and watched you teach math, how would he answer his question: Can this teacher teach it [math] with conviction, and with some feeling for its essence? Explain.

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## M $^{2}$ Innovations Learning \& Teaching Projects

Select a challenging problem or topic that you have studied in MSL and use it as the basis for a mathematics lesson that you will videotape yourself teaching to your students.

How can you present this task to the students you teach? How can you set the stage for your students to understand the problem? How far can your students go in exploring this problem? You want your students to discover as much as possible on their own, but there may be a critical point where you need to guide them over an intellectual "bump."

Produce a report analyzing the mathematics and your teaching experience.

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## TEAC 800 Action Research

"Action research is research done by teachers for themselves; it is not imposed on them by someone else" (Mills, 2003, p. 5 , italics in original).

In conducting action research, drawing conclusions isn't about making generalizations for others but about deciding on a course of action for one's own teaching.

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## TEAC 800 Action Research

- Course for planning action research projects in the fall semester; implementation in the spring semester
- 31 teachers
- 29 different research projects tied into individual problems of practice
- 3 research questions each
- 3 forms of data collection (both quantitative and qualitative) for each research question
- 31 literature reviews of at least 5 research articles each, connected to individual problems of practice
- 29 sets of IRB documents

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## M ${ }^{\mathbf{2}}$ Masters Degrees

- Two options for the Masters Degree
- MAT (Specialization in the teaching of middle level mathematics (Mathematics Department)
- MA (Teaching, Learning and Teacher Ed.)
- Masters exam in mathematics
- Take home exam (two math, one pedagogy question)
- Write an 8-10 page expository paper
- Give an oral presentation about the paper


## M ${ }^{2}$ Research Questions

- What are the capacities of teachers to translate the mathematical knowledge and habits of mind acquired through the professional development opportunities of $\mathrm{M}^{2}$ into measurable changes in teaching practices?
- To what extent do observable changes in mathematics teaching practice translate into measurable improvement in student performance?


## What are we learning?

- Integrate content and pedagogy courses.
- Keep expectations of teachers high.
- Emphasize learning how to learn and offer continued opportunities.
- Build on existing relationships.
- Commitment to the partnership need to be long term.

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