Mathematics and Science Partnerships Statewide Projects 2003-2008

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Foreword

Teachers make a difference in the lives of their students. Whether it is encouraging the reluctant reader, inspiring the math wiz, or nurturing the dreamer's creativity in science, good teachers love working with children and parents. Throughout our state, students, parents, and educators are working together to increase the achievement of all students and close the achievement gap. During the last six years, Wisconsin's Mathematics and Science Partnership (MSP) Initiative has provided teachers with the tools needed to make a difference in student achievement and advancement. Each partnership addresses content rigor in science, technology, engineering, and mathematics (STEM). Teachers gain new content knowledge by working with leading STEM university professors from around the state who are themselves involved in cutting edge STEM research. Through interactions with their peers, experts, and university professors, teacher's skills are enriched and enhanced.

I invite you to read about these exciting initiatives. Activity summaries and contact information for each initiative is available in this publication. You can learn how your school may become involved in one of the MSP initiatives or be a part of future MSP initiatives.

Elizabeth Burmaster
State Superintendent

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Acknowledgments

The following have provided help and support in many ways: by writing and reviewing drafts; by sharing materials; and by providing feedback and encouragement.

Special thanks to:

Division for Academic Excellence

Deborah Mahaffey, Assistant State Superintendent
Michael George, Director, Content and Learning Team
Roselynn Bittorf, Office Operations Associate
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Introduction

The reauthorization of the Elementary and Secondary Schools Act in January of 2002 also known as the No Child Left Behind Act of 2001 (NCLB) introduced the Improving Teacher Quality Grant Programs (Title II). These programs encourage scientifically-based professional development as a means for improving student academic performance. Professional development in science, technology, engineering, and mathematics (STEM) has grown stronger after the release of the results of the Trends in International Mathematics and Science Studies (TIMSS) formally known as Third International Mathematics and Science Studies. Thus, the focus of the Mathematics and Science Partnerships Grant also known as Title II, Part B is geared towards increasing the mathematics and science content knowledge of elementary and secondary school teachers. The Mathematics and Science Partnerships discretionary grant, is intended to increase the academic achievement of students in mathematics and science by enhancing the content knowledge and teaching skills of classroom teachers. This new program is based on a "change model" that requires *partnerships* between *high-need school districts* or Local Education Agencies (LEAs) and *Institutions of Higher Education* (IHEs) science, technology, engineering, and mathematics (STEM) faculty. The MSP conceptual model is based on research that has shown the direct relationships between teacher knowledge and skills and student achievement. The model is also based on the U.S. Department of Education findings that 50% of middle school math teachers lacked a major or minor in mathematics and low-income communities have even lower percentages of qualified teachers.

Grants were for two and three years. The projects focused on either mathematics or science, employed scientifically-based research, and have had an active and well-defined partnership among science, technology, engineering, and mathematics faculty and school district participants. Each project incorporated a summer institute combined with follow-up contact during the academic year that focused to enhance teachers' ability to understand and use *Wisconsin's Model Academic Standards for Mathematics* and *Wisconsin's Model Academic Standards for Science*.

These grants are showing results. Many school districts participating in the partnership grant program have shown significant increases in the percentage of students who are proficient or advanced on statewide testing. The 2006/07 statewide research clearly showed that teachers who participated in these projects have gained content knowledge significantly using a quasi-experimental design and the effect size statistical model.

History of Funding

Over the last six years (2003-2008):

- Wisconsin received approximately $10 million from the USDE.
- DPI awarded grants for 33 projects.
- 156 school districts with 21 higher education STEM institutes participated.
- More than 2,766 mathematics and science teachers participated in projects.
- 834 schools participated.
- Requests for grants from the Mathematics and Science Partnership program totaled $28.62 million.
- 43,000 students benefited from the projects.
- Average annual applicants are 15.
- Average annual awards are 6.

Twenty-six of these projects addressed mathematics which provided professional development in algebra, geometry, and statistics and probability to 1,865 teachers across the state. Each MSP project involved a wide range of responsibilities, including the design, implementation, and monitoring of the proposed professional development activities and evaluation of their impacts on teachers and student achievement. Seven projects focused on science at all levels. These projects provided high quality professional development in life science, physical science, earth science, chemistry, and physics to 901 teachers.

In addition, the MSP program led to the initiation of many programs and coursework related to middle school mathematics. For example:

1. The *La Crosse Partnership* (2005-2006) created a 10-credit graduate level certificate program for middle school mathematics through the Mathematics Department at the University of Wisconsin-La Crosse;

2. The *Milwaukee Partnership* created the "Math Fellow" program that offered a core sequence of four university mathematics content courses for a total of 12 credits. These courses were developed specifically for the Middle Childhood to Early Adolescence (MCEA) education mathematics minor. Thus, the UW-Milwaukee Mathematics Department provided a total of seven courses and 22 credits over the four semesters of the program; and

3. The *Madison Partnership* created a "Math Masters" program that consisted of four content courses offered through the UW-Madison Mathematics Department for one graduate credit per course. Follow-up professional development on pedagogy was provided by an LEA mathematics instructional resource teacher after three of the content courses.

Geographical Distribution of Projects

Green Bay: Mathematics and Science Partnership

Est. 2003

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Partners:

- CESA 7
- Green Bay Area School District
- Institute of Learning Partnerships, Green Bay
- Manitowoc School District
- UW-Green Bay

Abstract:

Green Bay Area Schools and Manitowoc Area Schools, in partnership with Cooperative Educational Service Agency 7 (CESA 7) and the University of Wisconsin – Green Bay, designed an intensive two-week summer workshop (ten days) to improve the mathematic content knowledge of forty-two (42) fifth, sixth, and seventh grade teachers of math. These content sessions were taped, edited, and are now available to all teachers within CESA 7. Following the summer session, a mathematics pedagogy class (ten sessions) was offered during 2005. Again, these sessions were also taped, edited, and made available for teachers within CESA 7. Three part-time teacher facilitators assisted teachers in their classrooms during the 2005-2006 school year as the teachers put into practice the information they had learned from the summer workshop and course. A listserv was also created for all teachers participating in the grant that allowed for communication regarding the classes, projects, and general sharing of information.

Introduction:

Needs assessments have been conducted in a variety of ways:

- The Manitowoc Public School District (2003) in a survey of teachers found the need for professional development focusing on mathematics content and instructional and assessment strategies for mathematics.
- A further survey by CESA 7 (2003) found the most critical content areas of need for mathematics teachers in the Manitowoc and Green Bay School Districts to be problem-solving, measurement, statistics, probability, and algebra.
- Drawing upon the findings of a regional survey of math teachers throughout northeastern Wisconsin, conducted three years ago, project designers are including content instruction in the following additional areas of mathematics: geometry, number and number operations, and computation and estimation.
- A needs assessment conducted in the Green Bay Area Public Schools further reveals that only four of the district's middle school math teachers have a major or minor in math.

Goals and Objectives:

Forty-two middle level teachers from the Green Bay and Manitowoc School Districts were the target audience for this project. The major goals/objectives for this project were:

1. Deepen math content knowledge and teaching practices of participating teachers.
2. Form teachers into "learning communities."
3. Provide support for teachers in the math classroom through "teacher facilitator" roles.

Program Plan:

The summer workshop ran the first two weeks in August of 2005. Dr. Asmamaw Yimer, in collaboration with Dr. Gregory Davis, both from the University of Wisconsin-Green Bay, created a syllabus for the workshop. Dr. Yimer took the lead in designing the pedagogy class held during the Fall of 2005. Forty-two fifth through eighth grade teachers from the Green Bay and Manitowoc School Districts participated.

The summer three-credit workshop addressed the Wisconsin Mathematics Academic Standards: Number Operations and Relationships, Geometry, Measurement, Algebra, and Statistics & Probability. Although the summer workshop was on mathematics content, conceptual understanding and procedural fluency were stressed as well. Knowledge of facts is important; however, knowledge of procedures – how and when to use them, the right time and the skill required to perform them correctly and efficiently are all critical to truly understanding math content.

The two-credit fall course covered mathematical pedagogy; three part-time facilitators in Green Bay and one facilitator from Manitowoc made follow-up classroom visits to each teacher These facilitators made observations and helped coach each teacher during the 2005-2006 school year.

Evaluation and Reflection:

The CESA 7 Mathematics for Middle School Teachers grant program was delayed a year. During that time the person who prepared the original evaluation plan departed and a new evaluator was contracted.

The evaluation work was changed to focus only on the summer 2005 nine-day mathematics content course taught through the University of Wisconsin-Green Bay to fifth through eighth grade teachers from the Green Bay and Manitowoc school districts. Originally the evaluation plan was to continue through the fall when the focus in the course and work of the project staff shifts to supporting teachers' classroom implementation of new mathematics instruction—both content and pedagogy.

In August 2005, the grant program officer made the requirement that student pretest and post-test data be collected in fall 2005 and spring 2006 among students in the classrooms of participating teachers and a "control" group of teachers. Results are shown below:

Student Achievement – Elementary Mathematics			
Control Group		**Treatment Group**	
Spring RIT minus Fall RIT	**Change**	**Spring RIT minus Fall RIT**	**Change**
214.8 – 209.5	5.3	217.2 – 210.1	7.1
Mean RIT scores for sample of participant's classes on NWEA MAP tests from Fall 2005 to Spring 2006 were compared and averaged for both groups. The change in RIT scores was determined and averaged.			
Student Achievement – Grade 6			
Control Group		**Treatment Group**	
Spring RIT minus Fall RIT	**Change**	**Spring RIT minus Fall RIT**	**Change**
223.5-218.9	4.5	226.8-219.2	7.5
Mean RIT scores for sample of participant's classes on NWEA MAP tests from Fall 2005 to Spring 2006 were compared and averaged for both groups. The change in RIT scores was determined and averaged.			
Student Achievement – Grade 7			
Control Group		**Treatment Group**	
Spring RIT minus Fall RIT	**Change**	**Spring RIT minus Fall RIT**	**Change**
229.8-223.7	6.1	234.0-228.4	5.6
Mean RIT scores for sample of participant's classes on NWEA MAP tests from Fall 2005 to Spring 2006 were compared and averaged for both groups. The change in RIT scores was determined and averaged.			

A mathematics survey consisting of 45 items was developed by the evaluator and administered as a pre- and post-test to teachers enrolled in the summer course. In late February, the evaluator met with the project staff to plan for the development of this instrument. The test was developed to assess general knowledge of the content to be covered in the course. The staff reviewed the draft instrument.

The pre-test was administered to 46 teachers at the April introductory meetings. A teacher information survey was also developed and administered with the pretest. Pre-test results and completed surveys were provided to the project staff in early May during a meeting at the annual conference of the Wisconsin Mathematics Council in Green Lake. The post-test was administered to teachers on the ninth day and final day of the UW-Green Bay summer course. For health reasons, one teacher took the test the following week. Two people, the evaluator, and a consultant whom the evaluator hired, scored the tests and reviewed the statistical data analysis on the scored tests.

Further evaluation data was also collected through site visits. The evaluator made two site visits to the summer course—August 5, at the end of the first week and August 10, the 8th day of the 9-day summer course. I observed, for example, Dr. Yimer presenting mathematics problems and asking teachers to share their solutions and teachers working problems in pairs or larger groups. Dr. Yimer had developed packets of materials for the mathematics content strands—number and operation, geometry and measurement, algebra, and statistics and probability. I observed the two district staff—Lori Williams and Pam Plamann circulate among the groups as they solved problems, answering questions, and making suggestions.

These site visits included focus groups with teachers and interviews with the course staff. Two teacher focus groups were held on August 5, with ten teachers per group. One focus group was held on August 10 with half the teachers from each of the previous groups. Upon request, the evaluator was provided and reviewed a random sample of 80 "reflections"—from eight days of the course—10 teacher reflections were randomly chosen for each day. Dr. Yimer gave daily course reflection assignments.

Overall, based on the reflections, assessments, and focus groups, the grant evaluator, Dr. Marge Wilsman felt that the math content of the teachers improved.

Literature Review:

The project activities proposed by the partnership submitting this application are designed on a foundation built around a review of scientifically-based research. The paragraphs which follow discuss and cite the current state of scholarly knowledge that supports this project. Through this brief review of professional academic literature, a clear indication of the rationale for selecting and designing the proposed activities may be discerned. This section also explains how the proposed activities may be reliably forecast to improve student academic achievement while strengthening the quality of mathematics instruction at the middle school level in participating districts.

The *National Council of Teachers of Mathematics (NCTM, 1989, 2000)* calls for reforms in mathematics instruction to move children beyond attainment of mathematical knowledge to the understanding of mathematical concepts, and the ability to apply their knowledge and understanding to relevant and meaningful problems. The Council recommends changes in instructional practices that transform classrooms from being teacher-centered to student-centered learning communities. Effective implementation of this change, however, requires professional development for teachers – not only in alternative instructional practices, but also in the understanding of mathematical content and alternative assessment strategies.

Carpenter and Fennema (1991) believe instructional decisions are based on analysis of student understanding. Therefore, teachers must gain an understanding of mathematical content and the ability to assess students' understanding of that content. *Greenes (1995)* contends that through the use of questions, the teacher becomes capable of assessing a student's level of understanding about a given mathematical concept. Questions provide teachers with information about students' understanding, enable students to connect prior knowledge with present learning, and require students to apply their knowledge to real-world situations. Therefore, the assessments that teachers should require students to do more than demonstrate their ability to memorize facts or information; students should be required to demonstrate what they understand *(Chuska, 1995).*

The *National Council of Teachers of Mathematics (NCTM 1991)* recommends that teachers respond to students' statements by asking questions that begin with "Why?" NCTM further recommends use of questions such as "What do the rest of you think about that? which require the students to reason mathematically. This technique of probing through questions enables teachers to determine students' understanding of mathematical facts, concepts, and procedures *(NCTM, 1993).*

With regard to the proposed learning communities, the success of clustering mathematics teachers into peer teams that form close-knit learning communities has been documented through the *PBS Mathline* project launched during the 1990s. Research into effective on-line learning communities documents that every member must contribute to discussions and have a voice if the potential of this strategy is to be realized; whereas in traditional face-to-face workshops, only about 30-40% of the participants speak and take an active role.

Additionally, with respect to on-site professional development, review of research by the National Council on Staff Development documents that staff development experiences are more effective when they are job-embedded, results-driven, and standards-based – as proposed in this partnership application. In its *Journal of Staff Development*, the council concludes that effective professional development must incorporate opportunities for teachers to analyze student work together and design new ways of teaching, experiment with new strategies, and reflect on the results. These kinds of job-embedded activities are most effective when they also include participating in a teacher network, observing model teachers, mentoring, and planning with colleagues ("Grounded in Research," *JSD*, summer 2001, page 32).

The technologies proposed for use in this project has exposed participating teachers to several features that have demonstrated – through scientifically-based research – positive effects on student achievement, including collaborative networks and design technologies through distance learning, video production, and on-line learning communities *(*"Does Technology Increase Student Learning?", *Research for Better Schools,* Fall/Winter 2003, page 2).

La Crosse: Mathematics Project
Est. 2003

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- Holmen School District
- La Crosse School District
- Onalaska School District
- UW - La Crosse

Abstract:

The project was designed to increase student achievement in mathematics by enhancing teacher content knowledge in mathematics through a ten-credit, applied, content-driven math certificate program.

Introduction:

The project was a joint effort among five school district partners (three of which were high-need LEAs - La Crosse, Norwalk-Ontario-Wilton, Blair-Taylor) to address the significant local and regional need for in-depth, content-based professional development in mathematics for middle level math teachers.

Goals and Objectives:

1. To reduce the number of teachers who do not meet the definition of "highly qualified teacher."
2. To increase teacher content knowledge in mathematics, higher-order thinking skills, inquiry-based learning, and technology integration.
3. To provide opportunities for teachers to implement their new knowledge and skills in their classroom and enrich their existing curriculum.
4. To increase student learning and improve student achievement outcomes in mathematics.
5. To foster the development and support of a middle school math professional community and cohort groups.
6. To provide outlets for course dissemination and widespread access to project materials and resources.

Program Plan:

During the project, a ten-credit certificate in middle school math education was established at UW-La Crosse and piloted with the project's participants. Twenty-five teachers started the project in summer 2005, and twenty teachers completed project activities in August 2006, resulting in 1,472 middle school students being impacted by the project participants. The math content and application activities were designed to specifically address both the Wisconsin state teacher standards and *Wisconsin's Model Academic Standards for Mathematics*.

Teachers completed three math credits during the summer of 2005, two math credits during fall semester 2005, two math credits during spring semester 2006, and three math credits during the summer

of 2006, culminating in a ten-credit certificate in middle school math education from the Mathematics Department at UW-La Crosse at the end of the summer of 2006 (providing all requirements were satisfied). During three weeks of classroom experiences in the first summer institute, math content included geometry and measurement, numbers and operations, and algebraic reasoning. The second three-week summer institute focused on statistics, probability, and functions and graphing. The two summer institutes were primarily face-to-face with web-based content and materials delivered on Desire2Learn, a web-based teaching platform. During the school year, nearly all project activities were on-line or involved independent or local group work. Teachers completed Problem Solving I during fall semester 2005 and Problem Solving II spring semester 2006, in which they engaged in implementation in the classroom, including inquiry-based teaching and problem-solving. All participants attended two face-to-face meetings during the school year. Teachers completed a pre- and post-test of the Praxis-like exam to assess growth and learning in math content knowledge. UW-La Crosse math faculty provided the math content and UW-La Crosse Sociology/Archaeology Department faculty provided the inquiry-based link between math content and real life applications.

Evaluation and Reflection:

In order to address the evaluation objectives, the methodology utilized multiple sources of information to provide evidence of the project's impact on each of the measurable outcomes. A variety of quantitative and qualitative data collection instruments were developed and administered during each stage of the project. A repeated-measure method was utilized to provide a longitudinal view of the effects of the professional development as it pertained to the evaluation objectives. This method was chosen to add "validity of inferences" across all phases of the project, not just one measurement before and after the project.

Description of Evaluation Instruments:

1. Self-Report Longitudinal Survey
2. Technology Survey
3. Real World Applications Survey
4. Reflective Journals
5. Praxis-Like Pre-Test and Post-Test
6. Content Course Pre-Test and Post-Test
7. Project-Developed Constructed Response Test
8. Classroom Observations and Teacher Interviews
9. Focus Group Interviews

Overall, this project demonstrated success in reaching the goals highlighted in the title. That is, the grant was successful in creating a 10-credit graduate level certificate program for middle school mathematics through the Mathematics Department at the University of Wisconsin-La Crosse. In addition, the project staff significantly achieved their objectives of increasing teacher mathematical content knowledge and preparedness to teach mathematics. Teachers indicated that their teaching expertise in pedagogical and assessment practices such as technology integration, inquiry-based learning, use of assessment aligned with WMAS, and use of real world applications also increased.

Unanticipated Outcomes:

- Overwhelming Number of Applicants: Recruitment activities were conducted all across Wisconsin to make sure that all project openings were filled. The project staff anticipated that there would be considerable interest in the project but did not expect the 114 applications for the projects' 25 openings.

- Control Group: Efforts to solicit 20 teachers to serve on the comparison group were limited due to a lack of interest. Even after providing stipends for the comparison group, data on only five comparison group teachers (including their students) were analyzed. Difficulty with soliciting a comparison group fell under two distinct categories:

    1. Comparison group teachers did not want to take the Praxis II: Subject Assessment without being able to take the mathematical content courses. These teachers noted that they were "afraid" that their scores would be sent to their school district and/or the Wisconsin Department of Public Instruction. In the end, this requirement was removed from the evaluation protocol for the comparison group teachers. Teacher content knowledge was examined through a Praxis-like pre- and post-test analysis.

    2. Comparison group teachers' hesitation regarding student achievement data was visible. Student achievement data was collected in the form of a project-designed constructed response test. Teachers were cautious about utilizing class time for more testing and allowing student work to be analyzed by an outside researcher.

- Teacher Concerns Regarding Taking Praxis: In addition to the concerns regarding the Praxis II Subject Assessment for comparison group teachers, participating teachers also expressed apprehension about taking the examination. As with the comparison group, teachers were hesitant about their scores being sent to various agencies without their consent.

Literature Review:

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Madison: Math Masters Project

Est. 2003

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Partners:

- Beloit School District
- Madison Metropolitan School District
- Sauk Prairie School District
- UW – Madison
- Deerfield School District
- Deforest School District
- Monona Grove School District
- Mt Horeb School District
- Oregon School District
- Sun Prairie School District
- Wisconsin Heights School District

Abstract:

Through the Math Masters Project, the Madison Metropolitan School District (MMSD) and the school districts of Beloit, Deerfield, DeForest, Monona Grove, Mount Horeb, Oregon, Sauk Prairie, Sun Prairie, Wisconsin Heights, and the University of Wisconsin-Madison Department of Mathematics joined forces to raise mathematics achievement via an ongoing, intensive, program of content-based teacher professional development that brought the partners' middle school mathematics teachers together in courses taught by UW mathematicians and applied mathematicians. In addition to content knowledge, teachers received content-specific pedagogical instruction and other forms of pedagogical support and modeling that will help them create standards-based mathematics classrooms and effectively utilize the "Connected Mathematics Project" (CMP) curriculum.

Introduction:

Within the partner districts, concerns exist regarding the achievement gap in mathematics between students of color and white students and between low income students and not low-income students. Low income students and those of color are performing well-below their higher income and non-minority peers. Clearly, Wisconsin Knowledge and Concepts Exam scores indicate that improvements in mathematics teaching must be made so that all students can achieve proficiency in mathematics.

A large majority—more than 90%—of project partners' teachers who teach mathematics are not certified in mathematics. And, more than 84% of these teachers do not have high levels of prior mathematics coursework (as evidenced by either a math major or minor in mathematics). In the Fall of 2003, the project partners distributed a two-page survey to all of these middle school teachers who teach mathematics (including ESL and special education teachers) to determine their needs for professional development in mathematics content. Ninety-nine teachers responded to this survey, and summarized results appear in the bulleted list below.

- 86% indicated that they need professional development courses designed to enhance mathematics content knowledge.
- 76% indicated that their colleagues need professional development courses designed to enhance mathematics content knowledge.
- 89% indicated that they are at least somewhat interested in professional development courses designed to enhance their content knowledge (29% are very interested, 35% are interested, 25% are somewhat interested, and 11% are not interested).
- The following mathematics topics were listed most frequently as those that teachers would most like to strengthen their content knowledge in: geometry/3D geometry, algebra, statistics, probability, pre-algebra, decimals, ratios, percentages, and fractions.

In addition to content, teachers indicated that they have a strong interest in additional professional development opportunities that: focus on inclusion and meeting the needs of all learners (special education through gifted); explore the use of technology in the middle school mathematics classroom; examine assessment and grading issues; provide for opportunities to share ideas, develop lesson plans, and meet with peers; offer opportunities for coaching and mentoring; explore CMP curriculum and guidelines in-depth; and, include an examination of how students learn math content.

Goals and Objectives:

The goal of the project was to increase middle school students' achievement in mathematics by strengthening the quality of mathematics instruction through the provision of content-based professional development linked to Wisconsin's Model Academic Standards for Mathematics and professional development on high leverage research-based strategies to develop student understanding. Project objectives were: 1) to increase the content knowledge of partnership district's middle school mathematics teachers; 2) to improve these teachers' understanding of how students learn mathematics; and, 3) to enhance implementation of the CMP curriculum within participating teachers' classrooms.

Program Plan:

The project offered four separate 20 hour content workshops throughout the 2004-2005 school year for participants from the Madison Metropolitan School District, Sauk Prairie School District, Beloit School District, and Juda School District. Each content workshop was designed to focus on a particular standard from the Wisconsin Model Academic Standards. Algebraic Relationships, Geometry, Measurement, and Probability and Statistics were identified as being the most influential at the middle school level. Each workshop offered an optional 20 hour course focusing on pedagogy that would be offered as online follow-up to the workshop. The topics for the pedagogy courses were based upon the Principles of Learning from the Institute for Learning out of the University of Pittsburgh. All four of the content workshops were offered again in the summer of 2005.

During the 2005-2006 school year, the project was expanded to include seven additional school districts in South Central Wisconsin. The content workshops and pedagogy courses were combined into 30 hour workshops with 10 hours of online follow-up. In addition, two extra workshops were created, an additional Algebraic Relationships workshop and a Proportional Reasoning workshop. Once again, the content portions of all six workshops were offered during the summer of 2006.

All workshops were developed and co-facilitated by a Madison Metropolitan School District Math Resource Teacher and a University of Wisconsin Mathematics Instructor. Problems for the workshop

were found in curricular materials used in the districts at the middle and high school levels. Problems were also generated from the UW instructors and the resource teacher. Participants worked on problems individually, in small groups and in large group discussions. The design of the problems had entry levels that matched out middle school standards. Through follow up questions, the concept was advanced through the high school standards and sometimes into college level content.

Evaluation and Reflection:

Pre-tests were given to participating teachers at the first session of each course. The same test was given as the post-test at the last session. The tests were developed by the district math resource teacher in conjunction with the UW STEM faculty course instructors to assess both general knowledge of related content and understanding of specific content to be covered in the course. All responses to pre and post-tests were rated twice by a MMSD resource teacher and a UW graduate student. The assessments required teachers to derive answers and to explain their approaches and reasoning. The change in scores was used as one source of information to evaluate the effectiveness of the courses. Overall, the teacher participants (most of whom did not have a mathematics related major as an undergraduate) gained in knowledge of the course content area. The effect sizes, comparing the average on the posttest to the average on the pretest, were all moderate or high.

During the 2004-2005 school year, there were 139 participants in seven math masters courses offered. Throughout the 2005-2006 school year, there were 287 participants in the twelve courses offered. Based upon anecdotal feedback from participants, teachers found the program to be valuable and relevant to the needs of their teaching situations. Teachers felt challenged by the content of the courses however a safe environment was created to allow for them to comfortably ask questions to expand their content knowledge. The steady increase of participants in the second year of the program demonstrates the positive response teachers had towards the program.

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Rice Lake: Northwest Wisconsin Partnership

Est. 2003

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- Menomonie Area School District
- Mercer School District
- Northland College
- Rice Lake Area School District
- Solon Springs School District
- South Shore School District
- Spooner School District
- Superior School District
- University of Wisconsin – Barron County
- Webster School District
- Winter School District
- WASDI
  - Gitche Gumee Academy
  - Star Academy

Abstract:

The Northwest Wisconsin Partnership for Mathematics and Science involved middle school teachers from twelve districts to deepen their understanding of science and mathematics content and pedagogical content knowledge while addressing the Wisconsin Model Academic Standards. Topics related to participant's teaching were introduced through lectures, labs, field work, and discussions. Time was spent collaboratively developing and sharing unit plans of selected topics. The activities related directly to the curriculum and subject area in which the teachers provided instruction. Activities were designed to enhance the ability of teachers to understand and use challenging content standards, and to provide teachers the opportunity to work with university faculty and experienced teachers. Mathematicians and scientists from the University of Wisconsin-Barron, Wisconsin-Eau Claire, Wisconsin-River Falls, Wisconsin-Stout, and Wisconsin-Superior delivered 16 days of professional development workshops. Facilitated electronic communication encouraged reflective dialog and ongoing collegial contact between staff and teachers. Participating teachers received a stipend, expenses, and up to six graduate credits were available.

Introduction:

A Wisconsin Academy Staff Development Initiative (WASDI) statewide needs survey of science and math teachers (4,279 surveys with 32% return) indicated that there was a strong need to provide assistance to teachers who have implemented standards-based curricula to strengthen their content knowledge of mathematics and science (WASDI 2002). Teachers also identified the need for time and

assistance for collaborative study and more opportunities to interact with teachers from outside of their district.

Interviews, both telephone and face-to-face, of superintendents, principals, and curriculum coordinators involved in the project, found a common series of middle school math and science needs: (1) Limited funds for staff development; (2) No coherent long-range professional development plan for mathematics and science teachers; (3) Lack of a seamless curriculum K-12; and (4) Many middle school teachers lacking a strong subject content background. Data collected for this project found that most middle level teachers, especially those from districts of under 1,000 students, were elementary certified, and had degrees in elementary education. Few had majors or minors in mathematics or science.

Weak areas identified by the WKCE for a sample school scoring at the top 25% of the partner schools at eighth grade were: Math: (operations, probability, statistics; processes, geometry, measurement; algebra, probability, and statistics); and Science (nature of science, environmental science, social perspectives, connections). It is probable that other schools are similar.

Equally important, the schools participating were identified by the Wisconsin Department of Public Instruction as high need districts. This designation was based on levels of proficiency and the percentage of economically disadvantaged students. This project, as a one year project, did not work directly to improve student achievement. The project was based on research that indicates that there is a relationship between the level of teacher knowledge and achievement of students.

The twelve districts involved in this project represented 35% of the state High-Need LEAs identified by the Wisconsin Department of Public Instruction.

Goals and Objectives:

Northwest Wisconsin Partnership for Mathematics and Science Education was designed for middle level teachers from 12 districts. The program assisted middle level teachers to:

1. Gain deeper understanding of science and mathematics content and pedagogical content knowledge.
2. Deepen their understanding of key research findings regarding curriculum, instruction, and assessment as they relate to mathematics and science education.
3. Develop personal and collegial relationships with other middle level teachers, university scientists and mathematicians, and state leaders in science and mathematics education.

Program:

Mathematics and science content covered in the two-week course at the University of Wisconsin–Barron centered on the mathematics and science needed to teach the Wisconsin Model Academic Standards to reflect performances expected at the end of grade 8.

In mathematics, approximately two days each of the instruction focused on Standards B through F: Number, Geometry, Measurement, Probability and Statistics, and Algebra. Standard A covers the processes of problem solving, communication, connections, and reasoning and was threaded through all of the other content sessions. The issue of the inter-relatedness of mathematics was emphasized by ensuring that each standard was addressed in isolation. The extraction of significant and worthwhile mathematical understandings from middle school mathematics lessons was a daily goal as well as the understandings necessary for teachers to accomplish this.

Science content instruction focused on Standard D. Physical Science: (1) properties and changes of properties of matter; (2) motions and forces; (3) transfer of energy; Standard E. Earth and Space Science: (1) structure of earth system, (2) earth's history; (3) earth in the solar system; and Standard F. Life and Environmental Science; (1) structure and function of living things; (2) reproduction and heredity; (3) regulation and behavior; (4) populations and ecosystems; (5) diversity and adaptations of organisms. A portion of each day was devoted to applying new information to the classroom curriculum and to collaborative lesson study planning with other participants.

Two, 2-day weekend sessions were held during the school year; one in the fall and one in the spring. During the summer, as well as the weekend sessions, time was provided for participant reflection and applying what they learned to their classroom practice.

All participants and staff were placed on WASDILine, the electronic conferencing system of WASDI projects. WASDILine activities included facilitated discussion of content topics, pedagogical approaches, and lesson study. Additionally, all science participants were placed on the Wisconsin Science Network, the Wisconsin edition of the National Science Teachers Association's *Building a Presence for Science* Program. This provided access to national and state information and sharing. An estimated one hour per week was spent online by participants.

Six graduate credits were available to the participants through their choice of institutions: UW-Eau Claire, River Falls, Superior, or Stout. Eighteen participants were awarded 108 graduate credits.

Evaluation and Reflection:

The evaluation of the Northwest Wisconsin Mathematics and Science Program was designed to provide ongoing formative evaluation for program improvement and a summative evaluation of the project goals. The purpose of the evaluation was to determine how successful the project was in meeting its goals and objectives.

The evaluator attended partnership meetings and attended classes and workshops with participants. Teachers were surveyed for their perceived value of the classes and workshops and the interaction with project staff and collaborating mathematicians and scientists. Interviews were conducted with teacher participants with a focus on how participation in the project benefited classroom instruction. Interviews were also conducted with project staff and partners for their perceptions on the success of the project and their perceived value of the project for participating teachers and districts.

Teachers were asked to rate their knowledge on the content topics at the start of the project. Science teachers perceived themselves well prepared in content (44%); math teachers rated themselves at 41%. By the end of summer, all rerated themselves higher with the largest gain by mathematics teachers (44%.) During the weekend sessions, 88% of the science and 66% of the mathematics teachers perceived themselves "learning to a great extent" from the experience. All participants rated the content as beneficial.

Another goal was to build networking opportunities for teachers. All participants perceived their strongest gains to be in the area of developing personal and collegial relationships with other middle level teachers, university scientists and mathematicians, and state leaders in science and mathematics education.

Teacher participation by the spring session had dropped. The dropouts were related to changes or termination in teacher contracts. Teachers were discouraged that they would not be teaching in 2005-06, or that they would be reassigned to teaching in a different content area. Two teachers lost interest in participation and did not provide a reason.

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Laona: Northern Wisconsin MSP - Physics

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Abstract:

The Northwest Wisconsin MSP – Science was a targeted program for teachers of physics in rural areas. The project provided 26 days of professional development sessions led by university scientists, experienced master teachers of high school AP physics, and industrial engineers. Seventeen teachers from fifteen districts participated. Participants were involved in lectures and lab activities using state of the art electronic equipment. All participants developed, evaluated, and shared classroom demonstrations relating to specific physics concepts. Graduate credit was available.

Introduction:

Needs were identified by the Department of Public Instruction by an analysis of student achievement data. DPI found that "the data also shows that high school chemistry and physics teachers need training in order to increase the student achievement in chemistry and physics, particularly in rural school settings." The resultant Request for Proposals specifically targeted this group. The need for physics content, pedagogical content knowledge, and the opportunity to interact with colleagues was confirmed through a WASDI statewide needs survey (4, 279 with a 32% return) and two focus groups.

Goals and Objectives:

The overall purpose of the Northwest Wisconsin MSP – Science project was to increase the effectiveness of physics teachers in working with students. Goals were to (1) increase participant content background in physics; (2) increase participant repertoire of standards-led and tested lab activities and demonstrations; and (3) establish a collegial and lasting relationship among and between participants, university scientists, engineers, and master teachers.

Program:

The Northwest Wisconsin MSP – Science was a targeted program for high school teachers of physics. The objectives of the project were to (1) increase participant content background in physics as evidenced by pre-post tests, surveys, and indirectly by credits earned during 26 days of instruction. This was deemed as accomplished by an outside evaluator; (2) increase participant's repertoire of standards-led and tested

lab activities and demonstrations as evidenced by a minimum of 15 collaboratively developed and conducted activities. This was accomplished with activities presented, critiqued, and shared on CDs and videos, and by presentations at the Wisconsin Society of Science Teachers (WSST) Annual Convention by all participants; and (3) establish relationships among and between participants, university scientists, and master teachers. This was accomplished as evidenced by participant surveys and by participation in the Wisconsin Science Network, NSTA memberships, and participation at the WSST annual conference.

The first two week summer session was held at University of Wisconsin-Barron County. A school year weekend session was held at the University of Wisconsin-Madison nuclear reactor lab, and another weekend session was held in conjunction with the WSST conference for paper presentations and interaction with other science teachers. The second two week summer session was held at Fond du Lac High School in their state-of-the-art physics laboratory. All sessions involved university scientists and master teachers. A daylong session with engineers from Mercury Marine stressed physics application in industry. A daylong session with engineers at Fond du Lac High School related physics to the geothermal heating and cooling of the very large building.

Sessions were characterized by formal presentations by university scientists and pedagogical applications led by a master teacher. Participants were engaged in lab activities, including using Logger Pro 3 that was provided. Demonstrations and the development of new lab activities were an integral part of each day.

Participants could earn 2-4 credits each summer for their work. Over the two summers (four weeks), seventy-five percent of the participants took the course for graduate credit (Educ 784 Teaching Physics – A Review). Seventy eight graduate credits were awarded through Viterbo University.

Evaluation and Reflection:

The evaluation of the Northwest Wisconsin MSP – Science program was designed to provide ongoing formative evaluation for program improvement and a summative evaluation of the project goals. Summative evaluation questions, based on the stated project goals, were:

- Did the participants increase their knowledge of physics concepts?
- Did the participants increase their effectiveness in working with students?
- Were professional relationships and networks established?

Content Knowledge:

Participants increased their content knowledge of physics. While all participants were certified teachers, there was considerable difference of background content knowledge and experience. A pre/post self reporting survey of nine physics content areas indicated significant increase in self rating of knowledge. Within the nine areas, three (kinematics, forces, kinetic theory) received special emphasis during the project. This emphasis was reflected in a 30% increase in the pre-post response of high knowledge.

The Force Concept Inventory was administered pre and post. An average normalized gain was used to analyze the data; $(g)=((S_{post})-(S_{pre})/100\%)- (S_{pre})$. Research conducted by Hake in 2001 found that in 48 interactive–engagement survey courses g = 0.48 while in traditional courses the normalized gain was 0.23. In this project the normalized gain was 0.5. This project was deemed highly interactive and heavily engaged the participants.

Effectiveness in Working with Students:

Participant pre/post self reporting provided an indication that skills associated with classroom effectiveness increased. There was especially significant need in mathematical modeling of data, misconceptions in physics, graphical analysis, and use of probeware. All participants reported that the quality and quantity of use of proven demonstrations increased.

Professional Networks:

The development of professional networks was considered one of the greatest accomplishments of this project by the evaluator, the staff, and by the participants. All participants became members of NSTA and WSST. All attended and presented papers at the WSST Annual Conference. None had previously attended, and none had ever presented a paper at a professional organization. All participants became part of the Wisconsin Science Network and have continued to remain active.

Formative Evaluation:

Formative evaluations based on surveys and observations were conducted daily during the summer sessions and at the end of each weekend session. All formative evaluations were shared with staff. All session activities were perceived as valuable by the participants. Of highest value were the opportunity to share, the work in the lab, and the class discussions.

Three program changes took place based on formative evaluations. (1) In response to the evaluations that the course appeared disorganized, a daily detailed schedule was printed and distributed. (2) A major issue was the presentation of mathematical modeling that was not at the level that the majority of students could understand. This was addressed by reducing the amount of math and by adding a historical discussion of the development of the model.

Another activity worthy of mentioning was web-based learning; specifically "Force and Motion." The participants were asked to complete and review the beta version of Science Objects. Science Objects was developed by NSTA with funding from NASA, NSF, and other sources. Al Beyers, the Project Director, visited and interviewed participants. There was general participant dissatisfaction with the time it took, but evaluations and comments indicated it was a valuable experience and many reported that it did increase their content knowledge. They also reported that it made them feel they were on the "cutting edge" of a program and they could (and did) make a difference.

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Milwaukee: Mathematics Fellowship for Middle Grade Teachers
Est. 2004

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Abstract:

The *Mathematics Fellowship for Middle Grade Teachers* project, a Wisconsin Department of Public Instruction Math and Science Partnership Program, was a collaborative effort of the Milwaukee Public Schools (MPS) and the University of Wisconsin-Milwaukee (UWM). The goal of the project was to increase the mathematics content knowledge of teachers in grades 5 through 8 in the City of Milwaukee. The "Math Fellows" were offered a core sequence of four university mathematics content courses for a total of 12 credits over four semesters from summer 2005 through summer 2006. The courses addressed mathematical problem solving, geometry, discrete probability and statistics, and algebraic structures. The content of these four courses targeted the mathematical knowledge needed for teaching the content of the Wisconsin standards in mathematics. All Math Fellows received a certificate of recognition from the district upon completion of the four core sequence courses. Some of the Fellows also entered into an accelerated program and completed two additional courses, intermediate algebra and calculus, to complete the course requirements for an elementary education mathematics minor and be eligible for additional state licensure endorsement.

Introduction:

The ultimate need for the project was the low level of MPS student achievement in mathematics. On the 2003-2004 mathematics subtest of the Wisconsin Knowledge and Concepts Exam (WKCE), 28% of the eighth grade students were proficient or above. This number was 38 percentage points lower than the state average, which was 65% proficient and above. The project was designed to address this achievement gap indirectly by addressing the need for greater teacher content knowledge in mathematics in grades five through eight.

MPS conducted a survey in November 2003 for 5^{th}-8^{th} grade teachers of mathematics. Eighty-nine mathematics teachers responded to the survey. According to the survey, only 6% of the group had a major in mathematics and 17% had a minor in mathematics. According to teacher licensing records, MPS had 836 active middle school teachers, but only 60 had a mathematics license (400 series). At the elementary level the situation was even worse, with only 49 elementary teachers having a 400 license out of 3,736 licensed teachers. The situation was not expected to improve as many K-5 schools in MPS were transitioning to K-8 schools. This was bringing about a reassignment of teachers from the elementary grades to the middle grades. Almost all of these teachers had a general 1^{st}–8^{th} grade teaching license. With the demands of middle grade mathematics content, many of these teachers felt under-prepared for the challenge.

Goals and Objectives:

The top three goals of the project were to:

1. Increase the number of teachers who participate in mathematics content-based professional development activities;
2. Increase the mathematics content knowledge of middle-grade teachers; and
3. Increase the number of highly qualified teachers of middle-grade mathematics, as defined by earning a MPS Math Fellowship certificate.

To attain these goals, the project offered participants a core sequence of four university mathematics content courses, for a total of 12 credits, over four semesters from Summer 2005 through Summer 2006, inclusive. All "Math Fellows" received a certificate of recognition from the district on completion of four courses. Some of the Fellows also completed two additional courses, including calculus, to complete the requirements for the UWM Middle Childhood to Early Adolescence (MCEA) mathematics minor. The completion of this minor along with other requirements allowed some participants to be eligible for additional state licensure endorsement. The target audience for the program was Milwaukee public and private school teachers of middle grades (5–8) mathematics.

Program Plan:

Following the award in December 2004, the *MFMT* program was advertised widely to MPS teachers and principals of K-8 and middle schools, and two informational meetings were held in the Spring of 2005. Interested teachers were then encouraged to submit a preliminary application, to determine whether or not they met the minimum requirements for admission to the program. As a result of reviewing these initial applications, it was decided to offer a foundational UWM course, MATH 175 *Mathematical Explorations for Elementary Teachers, I,* for applicants who did not meet the prerequisites for the core courses.

The core sequence consisted of four courses, developed at UWM as part of the NSF-funded *Milwaukee Mathematics Partnership* MSP: Problem-Solving and Critical Thinking, Geometry, Discrete Probability and Statistics, and Algebraic Structures. The course content was chosen to be particularly relevant for teachers of middle-grades mathematics; in particular, it targets the knowledge needed for teaching the content of the Wisconsin academic standards in mathematics. Multiple sections of each course were offered in the program. In order to complete the minor and be eligible for the license endorsement, participants also had to complete the UWM courses MATH 105 Intermediate Algebra, and MATH 211 Survey of Calculus. One section of MATH 105 was offered in Spring 2006, with one section of the calculus course the following summer.

Goal 1:

Following the award in December 2004, a timeline was established to advertise the program and recruit participants as shown in Table 1. By the deadline of May 10, application forms had been received from 80 teachers. Applicants were asked to provide a college transcript verifying their college-level mathematics courses. The transcripts were examined by UWM mathematics faculty, and a final determination was made, in consultation with the applicants, on the appropriate initial course placement. (It was at this point that the decision was made to add the prerequisite course, MATH 175.) Of the original 80 applicants, 50

enrolled in at least one Math Fellows course in Summer 2005. One applicant delayed enrollment until Fall 2005, and 3 late applicants also enrolled in Fall 2005; thus, a total of 54 teachers took at least one Math Fellows course.

Table 1. Timeline for Goal 1 – Increase Teachers Who Participate in Mathematics Professional Development

Timeline	Activity	Responsible	Result
Spring 2005	Publicity for *MFMT* program	MPS Math Curriculum Specialist, Math Teaching Specialists, and Math Teacher Leaders; UWM faculty	Heightened awareness of and interest in *MFMT* program amongst district teachers
March 22	Informational meeting	MPS Math Curriculum Specialist; UWM faculty	Approximately 30 teachers attended
April 14	Informational meeting	MPS Math Curriculum Specialist; UWM faculty	Approximately 30 teachers attended
May 10	Review of applications	UWM faculty	Prerequisite course added to *MFMT* offerings; 80 applicants admitted to program
Summer/Fall 2005	Review of late applications	UWM faculty	3 additional applicants admitted

Goal 2:

Math Fellows course offerings began in the Summer of 2005 and ran through the Summer of 2006. Table 2 lists the course sections offered and the enrollment for each section. Each of these courses is a regularly-offered course from the UWM mathematics department, although the content of MATH 105 and MATH 211 was slightly altered to make those courses more appropriate for teachers. MATH 275, 277, 278, and 299 are courses developed at UWM, with funding from the Milwaukee Mathematics Partnership grant, specifically for the MCEA mathematics minor. MATH 211 is a 4-credit course; each of the other courses is 3 credits.

Table 2. Results for Goal 2 – Increase the mathematics content knowledge of middle-grades teachers

Timeline	Course-Section	Topic	Instructor/Co-Instructor	Enrollment
Summer 2005	MATH 175-111	Number & Operations Foundations	Ruszkiewicz/Ford	18
	MATH 275-111	Problem Solving	McLeod/Kohlmetz	15
	MATH 275-112	Problem Solving	Kepner/Harris	11
	MATH 275-113	Problem Solving	Koker/Harris	15
	MATH 277-101	Geometry	Kepner/Hedges	11
Fall 2005	MATH 275-101	Problem Solving	McLeod	6
	MATH 277-102	Geometry	McLeod/Das	11
	MATH 277-103	Geometry	Kepner/Hedges	12
	MATH 278-102	Discrete Probability & Statistics	Stockbridge/Luck	17
Spring 2006	MATH 278-101	Discrete Probability & Statistics	Ruszkiewicz/Maly	9
	MATH 278-102	Discrete Probability & Statistics	Koker/Brenner	13
	MATH 105-142	Intermediate Algebra	McLeod/Das	18
Summer 2006	MATH 211-117	Survey of Calculus	McLeod/Kiblawi	12
	MATH 299-111	Algebraic Structures	McLeod/Maly	19
	MATH 299-112	Algebraic Structures	Kepner/Maly	5

Goal 3:

The third goal of the *MFMT* was to increase the number of highly-qualified teachers of middle grade mathematics, as defined by earning the MPS Math Fellowship certificate. In the original program design, the certificate would be awarded to Fellows who successfully completed the four MCEA math minor courses (MATH 275, 277, 278, and 299). In the event, due to time constraints or prior commitments, some participants were unable to enroll in MATH 299, which was offered only in the Summer of 2006, so the decision was made that they should be allowed to substitute MATH 105. Thus, the MPS Fellowship certificate was awarded to any Fellow who completed at least 12 credits from among these five courses. In addition, a "Math Fellows Participant" certificate was awarded to any participant who completed at least 6 credits. Table 3 shows the number of program participants in each of these groups. All credit totals are exclusive of the prerequisite course MATH 175, but it is particularly noteworthy that four Fellows began with this course and still succeeded in completing the Advanced Fellowship, taking a total of 22 credits through the program over 4 semesters.

Table 3. Results for Goal 3 – Increase the number of highly-qualified teachers of middle-grades mathematics

Number of Credits	Number of Participants	Certificate Awarded
6-9	14	Math Fellows Participant
12	17	MPS Mathematics Fellow
19	10	MPS Advanced Mathematics Fellow

The Math Fellows (and instructors) were recognized at an awards evening in September 2006, when most of them received their certificates. They were also recognized by the Milwaukee School Board at its meeting of November 30, 2006.

Evaluation and Reflection:

The program was evaluated by pre- and post-testing the Fellows for changes in their beliefs and efficacy on the Mathematical Knowledge for Teaching (MKT), using an instrument developed at UWM through its NSF-MSP grant; by pre- and post-testing them for changes in their MKT using measures developed at the University of Michigan and at the University of Louisville; and by asking them to complete an online survey after the completion of the program.

Changes in Beliefs and Efficacy on Mathematical Knowledge for Teaching:

The efficacy instrument includes six subscales: (1) efficacy for learning MKT, (2) beliefs about MKT, (3) efficacy to use mathematical knowledge in the tasks of teaching, (4) efficacy to use standards-based instructional approaches, (5) beliefs about teaching mathematics, and (6) beliefs about components of mathematical proficiency. Since the post-survey was administered at the conclusion of the program, the respondents are from the pool of participants that completed at least 12 credits and were awarded the MPS Math Fellowship Certificate or the Advanced Certificate.

After completion of the program, the Fellows reported statistically significant increases across all three efficacy scales. Thus, they reported greater effectiveness in their ability to learn the mathematical knowledge needed for teaching and to use it in their instructional practices. Of particular note, are the large increases in the Fellows' efficacy to identify how particular mathematical ideas grow and build upon each other in sophistication and abstraction, to design mathematical accurate explanations that are clear and useful for students, and to lead a class discussion in which students analyze and evaluate each other's mathematical thinking and strategies. In addition, significant change occurred in the Fellows' beliefs about teaching mathematics toward greater emphasis on conceptual understanding and value on student explanations.

Increases in Mathematical Knowledge:

In order to provide a quantitative, objective, measure of the Fellows' increase in MKT, measures were obtained from two sources: (1) Learning Mathematics for Teaching (LMT) project at the University of Michigan and (2) Diagnostic Teacher Assessments in Mathematics and Science (DTAMS) project at the University of Louisville.

The LMT measures were used to assess the participants' MKT in the areas of Number and Operations, Algebra, and Geometry. The Fellows showed improvement in all three areas. The greatest improvement was in algebra with a statistically significant mean gain of 0.35. A partial explanation for the relatively large increase in the Algebra scores may be that the algebra courses were offered towards the end of the program, and therefore closer to the post-test. Even though only the Algebra result is statistically significant, the Fellows' own assessment of their learning as well as course grades and instructor perspectives indicate increased knowledge in all areas. (A possible reason for this discrepancy is that the Michigan items are not closely aligned to the content of the UWM courses.)

The DTAMS instruments were used to assess MKT in statistics and probability. The four types of knowledge assessed were: Type I: Memorized Knowledge; Type II: Conceptual Understanding; Problem Solving/Reasoning; and Type IV: Pedagogical Content Knowledge.

The Fellows showed improvement in all four areas. Statistically significant gains were made in areas given greatest emphasis in the Discrete Probability and Statistics course: ideas of probability and Type III knowledge. There was also statistically significant growth in Type IV knowledge, probably because connections to classroom practices was a pervasive issue of reflection for the Fellows, given that they were classroom teachers.

Online Survey:

The Fellows' responses to the online survey consistently showed that the program met its goals: they feel more knowledgeable and therefore more confident in mathematics; they have a deeper understanding of how mathematics works and the interrelations between different content areas; and they believe they can now be more effective in developing mathematical knowledge and understanding in their students. As one Fellows participant remarked, "I really feel so much more confident when I'm in front of my fifth graders teaching math as a result of what I learned in the Fellows program."

Reflections:

Without doubt, one of the most important lessons we learned from this program is that there is both a great need and a great desire for teacher professional development programs focusing on mathematics content. Such a program should definitely start with MATH 175, or an equivalent course, even if it is expected that some applicants would not be required to take it. A second course covering basic ideas of geometry, probability and statistics, equivalent to the UWM course MATH 176, *Mathematical Explorations for Elementary Teachers, II,* would also be useful: many of the Math Fellows had weak backgrounds in geometry and statistics, which caused them extra difficulties in those courses. A problem-solving course should be offered as early as possible: for many of the Math Fellows, this was their first real experience of talking through and about mathematics problems, and it transformed their opinions of mathematics. The problem-solving approach surfaced throughout every other course in the program, and it was made possible by the fact that the Fellows were required to take this course first in the program. We would also argue that a Calculus course should be included, and that all participants should be encouraged to take it. Many middle-school concepts such as decimals, area and volume formulas, or speed and velocity, find a really firm foundation only in Calculus, and middle-school teachers should understand this foundation. Additionally, taking a Calculus course shows a teacher how many topics that they normally teach separately may need to be brought together to solve a single Calculus problem, and thus indicates the depth and breadth of knowledge that their students will require if they are to be successful in more advanced mathematics.

Literature Review:

The full literature review for the Math Fellows project is too lengthy to be included in this summary; the following items were particularly important.

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Ma, L. (1999). Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States. Mahwah, NJ: Lawrence Erlbaum Associates.

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Sharon: Understanding the World Through the Language of Mathematics: Math Literacy for All

Est. 2004

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Partners:

- Beloit Turner School District
- Cardinal Stritch College
- Dynamic Math Institute
- Fontana J8 School District
- Linn J6 School District
- Marquette University
- Sharon J11 School District
- Twin Lakes #4 School District
- University of Wisconsin–Whitewater
- Viterbo University
- Walworth J1 School District

Abstract:

The project vision centers on all students possessing the mathematical literacy and power to use critical thinking skills to solve complex problems, develop mathematical meaning that allows each student to make sense of their math work, collaborate with others to examine ideas and why they work, and communicate in a clear, accurate manner through a variety of venues.

The two-year project, *Understanding the World through the Language of Mathematics: Math Literacy for All,* is a partnership between Marquette University–Engineering Department in consultation with Dr. Robert Weber, Associate Professor of Engineering and six school districts in southeastern Wisconsin: Beloit Turner, Fontana J8, Linn J6, Sharon J11, Twin Lakes #4, and Walworth J1 that form the Southeastern Consortium (SE Consortium). Other partnerships include Dynamic Math Institute, an educational enterprise, UW-Whitewater Department of Education, and Cardinal Stritch Department of Curriculum and Instruction. Project Coordinators are Cora Rund, Big Foot Area Schools Association (BFASA), Curriculum Coordinator and Sally Taylor-Watson, Technology Coordinator at Sharon Community School. The project served middle school math teachers from the consortium and provided an opportunity for learning to other interested math teachers in the area who would like to participate.

The goals of the project are (1) increase student mathematical literacy, understanding, and achievement, and (2) increase teacher's content knowledge of mathematics, teaching skills to meet the needs of all learners, and knowledge of how students learn mathematics. By increasing teachers' content knowledge and skills in using inquiry, hands-on learning using mathematical tools, and grounding the student work with connections to the challenges in the real world, students will experience a rich, rigorous, and engaging learning environment that helps them utilize their math understanding to the fullest degree. Through the professional development design, teachers experience this type of learning environment, reflect on the connections to student work, and design an action plan of personal development to support their career goals.

The key features of the project are 1) learning teams using real-life applications, 2) lesson study, and 3) reflection, professional goal setting, and outreach. Benefits of the work include increasing use of constructivist teaching in the classroom, job-embedded support in implementing these practices and

curriculum, classroom activities, and complex-performance tasks aligned to the state standards, the district's learning targets, and mathematically powerful students prepared for the next level of education and daily life.

Introduction:

To obtain an initial picture of potential need in the SE Consortium, data from the WINSS site for the WKCE November 2003 provided information. Using the scatter plot and the bar graphs representing student proficiency levels, the broad picture indicates that all districts tested all students, that districts have varying degrees of poverty, and except for one district, the remaining districts have percentages of students at the Minimal and Basic level in Mathematics that exceed 10% for these two levels. All information reported for students represents the full academic year (FAY). See Table 1.1 below.

Table 1.1 Overview of Southeastern Consortium
Data Source: WINSS Mathematics Grade 8; WKCE November 2003

District	% Economically Disadvantaged	No WSAS	Minimal	Basic	Proficient	Advanced
Beloit Turner	8%	0%	20%	16%	52%	12%
Fontana J8	10%	0%	17%	8%	47%	28%
Linn J6	0%	0%	0%	0%	50%	50%
Sharon J11	31%	0%	19%	13%	53%	16%
Twin Lakes #4	19%	0%	21%	16%	29%	34%
Walworth J1	12%	0%	7%	19%	46%	29%

The second data set examined the math strands and index scores from the districts' Standard Performance Index report. The lowest strands across the districts included Number Operations/Relations, Geometry, Algebra, and Mathematical Processes. Other areas of need identified by the middle school teachers in a survey included the following pedagogical practices: inquiry-based learning, cooperative groups, student goal setting and self-evaluation, guided math groups, and project based learning.

The student achievement data indicated that all districts needed to reduce the percentage of students scoring minimal and basic in Mathematics. Key components for addressing this need are the enriched use of mathematical activities differentiated to meet the needs of all learners, the use of problem solving techniques, equitable access to best practices in each classroom, and partnerships between students, parents, and teachers. The second identified need was to support teachers by increasing their mathematical understanding and the use of pedagogical practices to support diverse learning needs. To develop this goal, the on-going professional development sessions employed teachers involved solving real world problems using math tools, working in collaborative teams, and developing reflective practice through the maintenance of a math journal or reflective papers.

Goals and Objectives:

Two overarching goals emerged from the needs assessment. The objectives serve as indicators of progress toward the attainment of the two goals.

1. Increase student mathematical literacy, understanding, and achievement.
   a. Increase the percent of students scoring at proficient and advanced on the WKCE.
   b. Students report a 10% increase in inquiry/hands-on activities in the math classroom.
   c. Students report a 10% increase in problem-solving activities and use of real life mathematical tools in classroom learning activities and assessment projects.
   d. Students report that they have experienced a math center activity at least 1 time/week.

2. Increase teacher content knowledge of mathematics, student's learning styles, and teaching skills.
   a. 100% of teacher participants indicate an increase of content knowledge using KWL format and reflection.
   b. Teachers report a 10% increase using problem solving and a 10% increase in the use of mathematical tools.
   c. Teachers develop and implement two lessons aligned with district curriculum and *Wisconsin's Model Academic Standards for Mathematics.*

Program Plan:

The program of study involved a ten day summer institute at 7.5 hours per day. Participants for the institute submitted a letter of application describing why they wished to attend and what they expected to accomplish by participating in the two-week institute. Each participant also needed to submit a letter of recommendation from their principal.

After all spaces in the institute were filled with SE Consortium teachers, then, according to the grant criteria, the remaining spaces were offered to schools districts in Walworth county, followed by schools districts in south central Wisconsin, and then from the state. We received applications from all of these areas and filled the summer institute. Summer institute teachers from the SE consortium received three follow-up days of training, three days of lesson study, and with the opportunity to sign-up for one day of coaching from the faculty, and/or one day of visiting another math classroom in another district for observation. Teachers from the SE Consortium that did not attend the summer institute received three days of training and three days of lesson study along with the opportunity for a coaching visit and/or the opportunity to visit another middle school math classroom in a different district.

The grant targeted 60 teachers from the member districts of the Southeastern Consortium to receive training as described above. We served 54 teachers from the SE Consortium, and an additional 10 teachers from outside the SE Consortium that participated in training sessions at different times throughout the grant. The follow-up training opportunities were offered to these 10 additional teachers. However, their districts had to provide substitutes for them at their own cost. Substitutes for the teachers in the SE Consortium were funded by the grant.

Teachers participating during the summer institute could elect three credits each week or a weekly stipend. Both groups had to complete the required work to obtain their funding. During the first year and second year of the summer institute, approximately 90% of the participants elected course credit from Cardinal Stritch University. All professional activities involved the teachers in hands-on, problem-solving activities. Dr. Robert Weber was key in helping teachers use games and hands-on activities to engage

students in real world problems. All faculty members involved the participants in the use of mathematical tools and interactive software including Geometer's Sketchpad and Fathom software. During the second year, participants prepared a summer math camp for 20 students. Students were selected by application.

Evaluation and Reflection:

Goal 1: Increase student mathematical literacy, understanding, and achievement.

Table 2.1 - Trend Data: Percent of FAY Students Scoring Proficient and Advanced
Data Source: WINNS Mathematics Grade 8; WKCE November 2003

District	WKCE 2003 – 2004	WKCE 2004 – 2005	WKCE 2005 –2006	WKCE 2006 – 2007	Change from WKCE 2003 and WKCE 2006
Training Description – Teacher training completed prior to WKCE testing	Baseline Data	Summer Institute Training for SE Consortium Volunteer Participants	Summer Training (2005) and three days of training and three days of lesson study for SE Consortium Teachers during the year	Summer Training (2006) for SE Consortium Volunteer Participants	
Beloit Turner	64%	72%	78%	80%	+16
Fontana J8	75%	92%	97%	100%	+25
Linn J6	100%	93%	100%	100%	0
Sharon J11	69%	86%	79%	81%	+12
Twin Lakes #4	63%	69%	76%	76%	+13
Walworth J1	75%	93%	97%	89%	+14

The change in the percentage of students scoring proficient and advanced from the baseline data from WKCE 2003 to the percent of students scoring proficient and advanced on the WKCE 2006 indicate that all districts in the SE Consortium demonstrated an increase. One district did not demonstrate an increase; however, the students scored 100% proficient and advanced in both years.

The next set of data is gathered from an annual survey of all grade 5-8 students and grade 5-8 math teachers in the SE Consortium. The SE Consortium grant proposal was modeled after a study used in Detroit and entitled, *Planning District-Wide Professional Development: Insights Gained from Teachers and Students Regarding Mathematics Teaching in a Large Urban District*, by Beatariz D' Ambrosio (Purdue University), William Boon (Indiana University), and Shelly Harkness (Miami University). The survey items used within this study were authored by Ohio's middle school math and science State Systemic Initiative (SSI: J.B. Kahle and K. Wilson, Principal Investigators). A Chi-squared item level analysis was carried out on the data. The SE Consortium used the same survey and the same analysis.

Students report a 10% increase in problem-solving activities, use of mathematical tools in the classroom, and experiencing a math center activity at least one time/week.

Perception surveys were given annually in May 2005 and 2006. The percentage for each year reflects the combined student responses for A (Almost Every Day) and B (Once or Twice a Week). In problem

solving, two positive changes occurred in problem solving out of eight survey questions and one positive response out of three for the use of mathematical tools. Students reported a 1% decrease in participating in math centers. See Table 2.2 for further details.

Table 2.2 – Grades 5-8
SE Consortium Student Perception Surveys: Questions Reflecting Student Perception of Using Problem Solving Strategies, Mathematical Tools, and Math Centers.

Question # Combined Responses for A (Almost Every Day) and B (Once or Twice a Week).	Percent of Student Responses in 2005	Percent of Student Responses in 2006	Change
Problem Solving Strategies			
#2 Students solve math problems in small groups.	52%	22%	-30
#6 Students write a few sentences about how they solved the math problem.	42%	41%	-1
#7 Students have to make up math problems for others to solve.	9%	6%	-3
# 9 Students do math projects.	11%	6%	-5
#10 Students complete worksheets at their desks.	88%	81%	-7
#12 Students have to answer questions that have more than one answer.	35%	37%	+2
#18 Students learn there are different solutions to math problems.	70%	80%	+10
#19 Students talk with their classmates about how to solve problems.	50%	37%	-13
Use of Mathematical Tools			
#3 Students work with hands-on materials (ruler, geometric solids, manipulatives).	26%	12%	-14
#4 Students use a calculator.	28%	26%	-2
#5 Students use a computer.	3%	6%	+3
Use of Math Center			
#11 Students go to a math center.	4%	3%	-1

A *P-value* was identified for each survey question. Table 2.3 details the survey questions and the *P-value* for survey questions indicating a significance level. Five questions out of 26 questions correspond to a significance level of $\alpha = .01$, which is a very strong indication that the difference from 2005 to 2006 cannot be accounted for by pure chance. Two questions correspond to a significance level of $\alpha = .05$, a strong indicated there were factors other than chance involved. One question has a significance level of $\alpha = .10$, which, although not as strong, still indicates the likelihood of outside factors. One of the outside influences that may be contributing to these findings is the possibility that teacher training coupled with sustained professional development, lesson study, collegial dialogue could account for the changes identified. Table 2.3 identifies the questions that show significance for the SE Consortium grade 5-8 student responses. The data indicates that students' perspective on problem solving, using math tools, and math centers are changing in their classroom.

Table 2.3 *P-Values* for the Grade 5–8 Student Surveys

P - Value	Question
0.000+	5. How often do you use a computer?
0.001	8. How often do you do math tests?
0.099	10. How often do you complete worksheets at your desk?
0.009	11. I go to a math center.
0.007	12. I have to answer questions that have more than one answer.
0.027	13. I have to give reasons for my answers.
0.032	16. I have to complete my homework.
0.061	18. I learn that there are different solutions to math problems

Goal 2: Increase teacher content knowledge of mathematics, student's learning styles, and teaching skills.

100% of teacher participants indicate an increase of content knowledge using KWL format and reflection.

Feedback forms, reflection papers, and entries from teachers' math journals indicate that 100% of the participants increased their content knowledge. More detailed analysis of what was learned appeared in the work of the teachers who attended the summer institutes (one or both years) along with the additional training. This detail of understanding may be due to the intense, sustained work of the summer institutes (10 days each summer) with reinforcement through the year with additional training and lesson study.

Develop and implement two lessons aligned with district curriculum and the Wisconsin Model Academic Standards.

All teachers in the SE Consortium collaboratively developed a lesson with their grade level team using the process of the lesson study, followed by observation of the lesson delivery, and finally, a data analysis from observational notes to identify strengths, weaknesses, and ultimately, using the findings to update the lesson. Participants received copies of the lesson developed through this process. Summer institute participants developed a lesson related to one of the math strands studied. The lesson required integration of math tools and a problem-solving approach. Lessons were delivered in the institute with feedback from faculty and participants.

Teachers report a 10% increase using problem solving and a 10% increase in the use of mathematical tools.

Teacher responses indicate gains in seven out of eight of the survey questions related to problem solving strategies. In the use of mathematical tools, teachers indicate an increase in hands-on material and use of the calculator. There is no change for the use of computers. According to the teachers, students are using math centers less than one or two times a week.

Table 3.1 Grade 5–8 SE Consortium Perception Teacher Surveys: Questions Reflecting Problem Solving Strategies used by the Teacher for Instructional Practice in the Classroom and Use of Mathematical Tools.

Question # Combined responses for A (Almost Every Day) and B (Once or Twice a Week).	Percent of Teacher Responses in 2005	Percent of Teacher Responses in 2006	Change
Problem Solving Strategies			
#2 Students solve math problems in small groups.	85%	90%	+5
#6 Students write a few sentences about how they solved the math problem.	69%	80%	+11
#7 Students have to make up math problems for others to solve.	15%	20%	+5
#9 Students do math projects.	8%	30%	+22
#10 Students complete worksheets at their desks.	42%	30%	-12
#12 Students have to answer questions that have more than one answer.	62%	80%	+18
#18 Students learn there are different solutions to math problems.	92%	100%	+8
#19 Students talk with their classmates about how to solve problems.	77%	90%	+13
Use of Mathematical Tools			
#3 Students work with hands-on materials (ruler, geometric solids, manipulatives).	75%	90%	+25
#4 Students use a calculator.	58%	70%	+12
#5 Students use a computer.	0%	0%	0
Use of Math Center			
#11 Students go to a math center.	31%	10%	-21

For the combined responses from SE Consortium Grade 5–8 teachers, there are no changes shown to be significant at $\alpha = .01$, $\alpha = .05$, or $\alpha = .10$ levels. When analyzing the teacher responses by the districts of Beloit Turner, Big Foot Association, and Twin Lakes, the data identified that all three districts had questions on the survey, including those for problem solving and use of mathematical tools at all three significance levels for grades 5, 6, 7, and 8.

Reflection:

The middle school grant provided sustained professional development. The current trend data provided on student achievement indicate gains between the baseline year 2003 and the WKCE 2006. The responses from the surveys indicate that students and teachers have very different perspectives about what is happening in the learning environment. As a result of this grant, the six districts joined with three other districts to write for a K-5 grant which was awarded this year. The middle school grant provided a strong foundation for building the new K-5 project. The most important lesson we learned by doing the grant was not to overwhelm participants with too many activities and concentrate on those that helped teachers

to understand more deeply the concepts of math and how to teach those concepts. Of all the follow-up activities, the lesson study component created the greatest "Ahas," stellar discussion, and probing questions as observed by faculty, the grant administration team, and identified in the participants' reflections and evaluations..

Literature Review:

The key research that guided the middle school math grant was the multi-year study from Ohio, *Helping Children Learn Mathematics*, 2002 from the National Research Council, and a comparative analysis of the characteristics of effective staff development that involved research from SERVE, Focus – ENC, Center for Performance Assessment, ASCD, and WINSS- Successful School Guide.

Blair-Taylor: Physical Science Inquiry Project
Est. 2005

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- Bangor School District
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- Blair-Taylor School District
- CESA 3 & 4
- De Soto School District
- Galesville-Ettrick-Trempealeau School District
- Holmen School District
- Melrose-Mindoro School District
- Montello School District
- Onalaska School District
- Pecatonica School District
- Royall School District
- Sparta Area School District
- University of Wisconsin - La Crosse
- Western Wisconsin Technical College
- West Salem School District
- Westby School District

Abstract:

The vision of the Physical Science Inquiry (PSI) project is to ensure that more highly qualified science teachers were part of the educational infrastructure in western Wisconsin resulting in increased student learning and performance. To achieve this vision, the University of Wisconsin – La Crosse, Western Wisconsin Technical College, CESAs #3 and #4, and 57 potential LEAs (of which 11 are considered high need in science) formed the Western Wisconsin Science Collaborative Initiative (WWSCI). The partnership was formed on the premise that student achievement could be improved only by enhancing the content knowledge and the quality of instruction by science educators.

The PSI project is built upon the numerous successes that were espoused and demonstrated by teacher participants in a similar pilot project conducted in 2004–2005. Based on nine national, state, and local needs that were determined by the WWSCI, five project goals were identified: 1) curriculum alignment, 2) science content, 3) constructivist pedagogy, 4) learning plans, and 5) student achievement. Teachers participated in an intensive two-week summer Washburn Academy using the scientifically-based Operation Primary Physical Science (OPPS) program. Trained IHE faculty taught eight units of physical science content that is centered on *Wisconsin's Model Academic Standards for Science* and inquiry-based teaching methods over the three year period. Participants applied the new knowledge gained and pedagogical techniques learned by developing standard-based learning plans. Grant funding paid

instructor salaries and academy fees, provide support stipends, and purchase equipment and software for learning plan implementation.

Quasi-experimental and experimental research designs were used to collect qualitative and quantitative data concerning both teacher performance and student achievement. Data from pre- and post-content tests, an inquiry-based self assessment, journaling, and assessment rubrics for the learning plans were used to provide teacher feedback. The Survey of Enacted Curriculum (SEC) provided valid and reliable data on the alignment between state standards and what is actually being taught. Student achievement gains were measured against established baselines using WKCE proficiency scores and Standard Performance Indicators (SPI) data. Additionally, pre- and post-Tier II standard-based assessments were randomly administered to paired classroom sets of students in a control and treatment format.

Introduction:

The primary intent of NCLB is to provide all children with a fair, equal, and significant opportunity to obtain a high-quality education delivered by highly qualified teachers. In 2007, science became subject to mandatory testing with schools being rewarded or sanctioned according to the provisions of NCLB. Numerous studies have consistently shown that American students perform at substandard levels in science when compared with students from other industrialized countries.

In a 1995 report, U.S. 4th graders ranked above the international average, while U.S. 8th graders fell to the middle, and U.S. 12th graders ranked among the lowest scoring countries (National Science Teachers Association, 2001). Recent *Trends in International Mathematics and Science Study (TIMSS)* data shows there was no measurable difference detected in the average science performance of U.S. 4th graders between 1995 and 2003. However, the standing of U.S. 4th graders in science relative to their peers in 14 other countries appears lower in 2003 than in 1995. Particularly disturbing is the fact that the U.S. is one of four countries in which boys turned in lower science performance in 2003 than in 1995 (National Center for Educational Statistics, 2005). The question must be asked why U.S. students fail to keep up with their peers in other countries and, in fact, even show declining academic achievement in science as they progress through school. In Wisconsin, declining state science scores (*See Table 1)* parallel national statistics. These test scores fly in the face of common sense, given the innate creativity and curiosity of young children.

Investigation of longitudinal trends using additional state and local WKCE data also indicate declining student achievement in science at the eighth grade. For instance, Objective/Standard Performance Index (OPI/SPI) data (i.e., a statistic for estimating the number of items a student would get correct out of 100 items) indicate student mastery declined significantly in Physical Science from 1999-2003 with a slight increase in 2004 *(See Table 2).* The decline in Physical Science (compared to Life and Earth/Space Sciences) represents the greatest area of need.

Why do science scores decline? One reason for the drastic decrease in student performance is that students lose interest in science as they progress through school. Studies have shown that one of the primary reasons for poor student performance and lack of student interest in science is that teachers are not adequately prepared to teach science content, particularly in Physical Science. The average elementary (K-8 certified) teacher has taken only one college course in science (*Freundlich*, 1998).

The American Association for the Advancement of Science in their 1998 *Blueprints for Reform: Science, Mathematics, and Technology Education* elaborated on similar needs in professional development:

> "Master's degree programs in education offer in-depth study but lack science content and strong ties to individual instructional practice. Workshops lasting one or two days do little to improve teachers' understanding of their subject matter. Teachers are taught in "make it, take it" sessions how to conduct a particular set of activities or lessons. Neither of these approaches is satisfactory."
>
> "To support science instruction with activities tied to specific standards and benchmarks, professional development work must address more directly the curricular issues of sequence and connection with benchmarks and standards. The chances for successful reform were enhanced by a focus on standards-based professional development that builds the scientific and instructional knowledge necessary for real curricular and instructional change (*Blueprints for Reform*, 1998)."

Statewide needs assessments confirm that substantive professional development is needed by science teachers. According to the 2001 Wisconsin Academy Staff Development Initiative (WASDI) Science Needs Assessment, 89% of science teachers stated that extensive professional development was necessary in order to implement a standards-based curriculum. Items receiving the highest rankings of need were implementing effective technology as an integral part of science instruction, assessing children's understanding of science, and sharing and developing science curricula.

In October 2003, the WWSCI designed a local needs assessment to discern the professional development needs of CESA 4 teachers in science based on the WMAS. The survey instrument addressed three perceived needs: 1) teacher perceptions of their own content knowledge, 2) teacher perceptions of students' content knowledge, and 3) perceived needs in effective instructional practices. Survey results revealed that across the board LEAs in CESA 4 reported high need for improved science content knowledge on the part of **both** teachers and students:

- Teachers rated themselves as having medium to high needs in content knowledge related to seven of the eight science content standards. (The exception was WMAS Science Standard F: Life and Environmental Science.)
- Teachers rated students as having medium to high needs in content knowledge in seven of the eight science content standards. (The exception was WMAS Science Standard F: Life and Environmental Science.)
- Teachers expressed medium to high needs for professional development in standards-based lesson design, constructivist pedagogy, and use of balanced assessment strategies.
- Teachers expressed medium to high needs for updated materials, equipment, and resources for science instruction, including training in software integration.

Table 1: WKCE Results

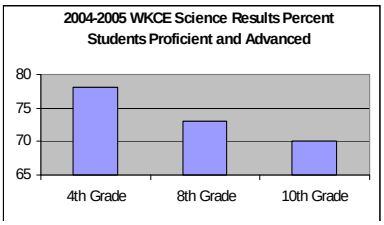
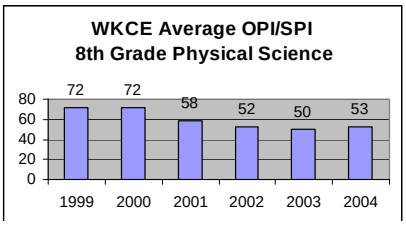


Table 2: WKCE OPI/SPI Data



Research findings, test results, and needs assessment survey data, confirm the need for improved student achievement and enhanced teacher quality. Additionally, 11 of the 37 LEAs (30%) that meet the grant's eligibility criteria as a high need LEA in science are located in CESA #3 and CESA #4. Table 3 summarizes the nine national, state, and local needs identified by the WWSCI planning committee for the PSI proposal.

Table 3: Summary of WWSCI Needs

Identified Need	Description
Student Achievement	Increase student achievement in science.
Professional Development	Provide high quality, rigorous, on-going, and sustained professional development.
Physical Science Content	Update teacher content knowledge in physical science.
WMAS Knowledge	Enhance teacher knowledge of the WMAS.
Aligned Curriculum	Align science curriculum with WMAS.
Constructivist Pedagogy	Implement inquiry-based, constructivist pedagogy.
Balanced Assessment	Employ balanced assessment strategies.
Teacher Incentives	Offer stipends and credit opportunities to encourage teacher participation.
Resource Allocation	Provide technology training, equipment, and resources.

Goals and Objectives:

The purpose of the PSI proposal is to support Wisconsin's NCLB goals of enhancing student achievement and having all students taught by highly qualified teachers. To achieve this purpose, the WWSCI has identified five goals based on nine previously identified national, state, and local needs. The goals of this proposal are:

- **Curriculum Alignment**: Align science curricula and learning plans with the Wisconsin Model Academic Standards (WMAS) and Assessment Frameworks for Science.
- **Science Content:** Train 30 elementary and middle school teachers annually in rich, contextualized physical science content and concepts.
- **Constructivist Pedagogy:** Train 30 elementary and middle school science teachers annually in inquiry-based, constructivist pedagogy.
- **Learning Plans:** Develop and disseminate 30 elementary and middle school physical science learning plans that are aligned to the Wisconsin Model Academic Standards (WMAS).

- **Student Achievement:** Increase student achievement in science as measured by WKCE SPI data and Tier II classroom assessments.

Program Plan:

As part of an effort to improve student academic performance in CESA 3 and 4 schools, CESA 4 partnered with the University of Wisconsin - La Crosse (UW-L), Western Technical College (WTC), and area school districts to enhance the content knowledge and teaching skills of upper elementary and middle school science teachers. Although the primary target audience was science teachers in "High Need" or "In Need of Assistance" schools, we were able to offer the opportunity to teachers in grades 2-8 throughout CESA 3 and CESA 4.

This grant project was originally written for 30 participants. Due to an extremely positive response, permission was sought and received to serve everyone who applied. At one point it appeared there could be as many as 43 participants the first year, but in the final analysis, a total of 38 teachers participated in summer workshops in Year One. Forty teachers participated in Year Two, representing 25 repeats and 15 new teachers. The program was offered to teachers in grades 2-8, although on a case by case basis several exceptions were made, including a technology education teacher and a high school special education teacher. A total of 20 school districts have participated in the project so far, including 11 private schools. For two years, participants have attended two weeks of training in conjunction with the Washburn Academy, (July 10-14 and 17-21, 2006 and July 16-20 and 23-27, 2007), as well as follow-up sessions during the school year. In one or two situations, the first year participants could not attend both weeks, or teachers from a district teamed up to make sure someone attended each week.

In support of Wisconsin's NCLB goal of improving student achievement by having all students taught by teachers who are highly qualified, the WWSCI partnership identified five goals: 1) Curriculum Alignment, 2) Science Content, 3) Constructivist Pedagogy, 4) Learning Plans, and 5) Student Achievement. The format developed to achieve these goals included two weeks, annually, of summer instruction, two follow-up sessions during each school year, development of learning plans later shared among participants, and provision of resources to develop new inquiry-based science lessons.

As the centerpiece of the grant, the summer courses included instruction in science concepts based on Operation Primary Physical Science (OPPS) from UW-L and WTC science faculty. Topics were taught modeling inquiry-based, constructivist pedagogy. Participants have been provided time to work on curriculum alignment, time to practice hands-on laboratory investigations, and time to collaborate in the development of projects and lesson plans.

Evaluation and Reflection:

Various accountability criteria and activities were established in the original proposal for each of the grant goals in order to monitor progress and continuously enhance overall program effectiveness. Several additional evaluation tools were developed during the first two years to capture more specific data. The grant planners chose Dr. Thomas Guskey's five level model for evaluating professional development, with project goals and evaluation strategies as outlined below.

Summary of Evaluation Strategies		
Guskey's Evaluation	**Goals**	**Evaluation Strategy**
Participants' Reactions	3. Constructivist Pedagogy	Pre- and Post-Inquiry Self-Assessment Reflective Journals Washburn Academy Evaluations Interactive Web Forum for Dialog
Participants' Learning	2. Science Content	Pre- and Post-Content Test Reflective Journals Summary and Workshop Questionnaires
Organization Support and Change	1. Curriculum Alignment	Survey of Enacted Curriculum (SEC) Assessment Framework Document
Participants' Use of New Knowledge and Skills	4. Learning Plans	Peer Review of Learning Plans Learning Plan Template Reflective Journals
Student Learning Outcomes	5. Student Achievement	WKCE-CRT Comparison Data Pre- and Post-Tier II Assessments

High quality data was obtained providing evidence of significant improvement in science content knowledge through the use of Pre-and Post-Content Tests, Reflective Journals, and workshop evaluation instruments.

Content Area Pre- and Post-Tests:

Content instruction is at the heart of this grant and dramatic improvements in content knowledge show that goal is being achieved. Pre- and post-tests have been administered in four content areas to date: Year One in Matter and Motion and in Year Two in Electricity and Magnetism. Significant gains were noted by most participants in all four units of instruction. Please see the tables in the Annual Performance Report for scores, gain scores, and averages.

Several observations are notable, beginning with the pre- and post-tests on Matter and Motion. In a few cases, students scored fairly well on their pre-test, but in no case did anyone get all questions right on their pre-test. While the average gains of 4.08 and 3.49 on the Matter Post-Test and the Motion Post-Test respectively are impressive, it is even more dramatic to note that 5 participants achieved gains of seven or eight points. The abysmally low scores of some participants on the pre-tests (0, 1, or 2 in quite a few cases) further demonstrates how critically important it is to improve teacher content knowledge. The same generalizations held true for the unit on Electricity and Magnetism in the second year. Basic background understanding was most lacking in the area of Electricity, with 25% of participants scoring 0, 1, or 2 on the pre-test and only 50% of participants scored higher than 3 on the pre-test. Similarly, the highest average gain scores were achieved in the Electricity unit with an average gain of 5.08 on the post-test. Participants realized average gain scores of 4.00 on the Magnetism Post-Test.

Reflective Journals:

One of the most outstanding features and greatest strengths of the instructional program was the opportunity for workshop participants to reflect on their learning and ask clarifying questions in their Reflective Journals. Journal entries were submitted via the grant website. Each day during the summer workshop began with a review and clarification of questions from the previous day's instruction. Follow-

up instruction was always provided by a different instructor so that participants had the opportunity to hear concepts explained in a new way. As one teacher observed, "It was overwhelming at times, but I liked how some main points were repeated many times!"

Workshop Evaluations:

The newly developed Feedback Form for Year Two enabled participants to identify what factors contributed to the overall workshop quality and to future classroom applications. With a score of 1 being Not Important and 5 being Very Important, "high quality content instruction" received a score of 4.87. When asked what was the best part of the workshop experience, comments such as the following were common:

- Taking a complicated topic in science (for me) and making it so much easier to understand.
- The knowledge.
- I learned so much, and I am excited to teach science next year.

In addition, one of the questions on the WASDI Evaluation Form asked whether the workshop "Increased my knowledge of the subject matter, processes, and instructional strategies in this content area." On a four point scale, the mean score in year one was 3.78 with 83.8% giving the workshop an "Excellent" and 10.8% scoring it "Good." In year two the ratings improved, showing a mean score of 3.93, with 92.5% saying "Excellent" on that question and 7.5% saying "Good."

Survey of Enacted Curriculum (SEC):

Grant planners chose a quasi-experimental research design using a scientifically-based research instrument, the SEC. Data from the SEC-assisted teachers in analyzing the degree of alignment among the standards and their instruction and assessments and in analyzing their emphasis on various instructional attributes, such as inquiry activities, over time. All grant participants have taken the SEC during their first week of summer instruction. (Results have not yet been received for second year participants.) The benefit of the SEC administration has been to create awareness of instructional practices and to establish a baseline.

The SEC was used in a pre- post-test format. In the third year of the project, participants retook the SEC allowing a determination of whether the grant project was effective in improving alignment among the standards and instruction and assessment.

Learning Plans:

So far twenty-two constructivist learning plans have been compiled. Twelve learning plans, from year one, were distributed to all first and second year participants. Ten learning plans were received from year two participants and were distributed at a follow-up meeting on October 17, 2007. The learning plans were based on the Karplus Learning Cycle and aligned to the appropriate WMAS. The lessons were reviewed by the grant manager (in some cases enhanced), put in a standardized format, and feedback given. One flaw in the first year of the program's administration was not requiring the learning plans to be turned in at the end of the summer workshop. In 2006 the plans were not due until fall, with the predictable result that many assignments were very late. In addition, participant feedback showed that instructors should have been more explicit in format expectations for the learning plans. Delays in the

receipt of teachers' plans, work backlog, timing issues on the part of the grant manager, and inconsistent products from teacher teams resulted in the unfortunate situation of learning plans not being reviewed, compiled, standardized, and published until the following summer. The final product, a binder of ready-to-use constructivist learning plans is an excellent resource.

Based on the first year's experience, teachers in the second year were provided with a template for their lesson plans and a sample lesson. Instructors provided explicit instructions, walked through the template in detail, and provided exemplars for each section. Class participants were required to turn their learning plans in by the last day of the summer workshop. Although more work was required during the two weeks of the workshop, the binder of learning plans was available to participants in October, in time to utilize during the school year. As a result of the new template and sample, the final products were also more consistent in their quality. The exercise accomplished the additional goal of reinforcing the learning that took place during the workshop. According to one participant, "Having to create a lesson plan implementing one of the concepts covered required me to practice how I would develop and structure hands-on lessons for my students." Many evaluations voiced similar sentiments regarding the value of creating and receiving the learning plans, as well as the benefit of developing the plans collaboratively in a format which allowed teachers to learn from each other. In both years, follow-up sessions have allowed teachers to share their experiences teaching the lessons.

Student Achievement:

One of the biggest challenges has been providing valid and reliable data regarding student achievement. With student proficiency in science only measured in grades 4, 8, and 10 on the WKCE-CRT, trend analysis is not possible using a self-referencing format. Individual student achievement results cannot be tracked from year to year. Moreover, test security protocols make it unlikely that individual student test data could be obtained for all students. The November testing window for administering the WKCE-CRT further limits the value of the standardized test as a measure of the grant project's effectiveness. Teachers have very little time between their summer workshop and the WKCE-CRT for students to benefit from the teacher's instruction and learning plans. An additional unanticipated difficulty in obtaining valid and reliable student achievement data has been the presence of teachers from parochial/private schools in the participant pool. With private schools not being required to administer the WKCE-CRT, student test data would not have been available even if other test-related problems were not present.

In view of the lack of available student achievement data from the WKCE-CRT, the grant planning team, in consultation with grant administrators at the state level, determined that student achievement could be assessed more effectively through the use of a Tier Two science content test. The test was developed using recognized measurement principles and is based on the WMAS and science content taught during the summer workshop. This test was piloted with students for the first time in 2007-2008 in a pre- post-test format.

Anecdotal evidence provides convincing indications that students have responded positively to their teachers' more constructivist teaching styles. In a survey given to participants in April, 2007 after utilizing inquiry-based methods and new equipment throughout the school year, teachers were asked what effect their own instruction had on student learning and engagement in science. The following responses are typical:

- "Assessments in units where my students were able to 'lock their learning' with hands-on activities scored higher than those where I just used visual materials and discussion. My students also were consistently eager to 'DO SCIENCE'."

- "The students have been more involved and comprehension of subject matter has increased. It has made science 'fun'."
- "My students enjoyed all the labs I brought back from this class. All students were engaged in the discussions, activities, and follow-ups. My evidence comes from talking with them and their parents, watching them participate in class, and when I checked the work."

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Kenosha: Middle Mathematics Mobilization Program (M^3P)
Est. 2005

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Abstract:

The Middle Mathematics Mobilization Program (M^3P), a coordinated effort of Kenosha Unified School District (KUSD) and Carthage College, is designed to increase the mathematics knowledge of KUSD grades six thru eight middle school teachers and their students. M^3P strives to ensure that the goals of the Elementary and Secondary Education Act (ESEA) are attained in the area of mathematics.

M^3P enabled our participating middle school math teachers to develop further experience in subject content, teaching strategies, uses of technologies, and other essential elements in teaching to high standards.

Introduction:

Instruction at the middle school is critical to the performance and achievement as students transition to the high school. Students who are prepared for Algebra I or Core Plus I in high school are more likely to succeed than those students who are still struggling with math computation, number sense, measurement, geometry, algebra, and other logic fundamentals that serve as the foundation for higher mathematics. KUSD students need middle school teachers who are knowledgeable and enable them to be prepared for high school mathematics and beyond. Teacher knowledge and formal training as described in the M^3P are vital to improving student achievement.

Currently, 66% of the KUSD middle school teachers are highly qualified by NCLB standards. The current middle school teachers hold at least a bachelor's degree, have completed an approved college or university program, or are teaching on an emergency or provisional license that meets the federal criteria of highly qualified.

However, these middle school teachers were not exposed to the rigor and assessment of mathematics that is required of current college graduates who are required to pass the PRAXIS II as part of their teacher certification. Through M^3P, middle school teachers, already highly qualified in the areas of certification and licensure, enhanced and expand their expertise in mathematics. Upon completion of this program, they may choose to complete two or three additional courses to earn a minor or concentration in mathematics.

Less than 65% of the KUSD grade 8 students were proficient/advanced on the WKCE. In 2003-2004, 60-61% of the students were proficient/advanced. The grade 8 WKCE Mathematics Percent of Students Proficient/Advanced by Group for 2000-2001 to 2004-2005 shows that while performance in mathematics

has improved, there still is an achievement gap for economically disadvantaged, students with disabilities, English Language Learners, Hispanic, and Black populations of students.

Goals and Objectives:

The M^3P project is intended to support middle school teachers of mathematics who are highly qualified as middle school teachers but do not have a mathematics background. These seventeen middle school math teachers will:

1. Better know and understand those mathematics concepts necessary to teach mathematics at their grade level and beyond;
2. Design effective units and lessons of instruction based on KUSD middle school mathematics benchmarks as well as on best practices in instruction;
3. Better understand the central concepts of mathematics, tools of inquiry, and structures of the discipline in order to create learning experiences that make the aspects of mathematics meaningful to students;
4. Learn how to formatively and summatively assess student work and adjust instruction according to assessment results;
5. Help students make sense of mathematics; and
6. Earn a M^3P Certificate of Completion from the Kenosha Unified School District Board of Education.

Program Plan:

M^3P participants completed four Carthage College mathematics courses during school years 2006-07 and 2007-08 for a total of sixteen credits. These include Math 106-Elementary Statistics, Math 121-Discrete Structures, Math 205-Modern Geometry, and Math 200-Linear Algebra. Participants also attended two summer sessions of the Chiwaukee Academy, Math 103-Applied Math Part 1 during 2007 and Math 103-Applied Math Part 2 during 2008, increasing total credits earned to twenty. At the Academy, teachers met to discuss and share their newly created mathematics lessons and how they are aligned with content and with KUSD standards and benchmarks. Seventeen (17) teachers are enrolled in the program. To date, they have completed Math 106-Elementary Statistics and Math 121-Discrete Structures. They are currently enrolled in Math 205-Modern Geometry.

Evaluation and Reflection:

The Learning Mathematics for Teaching (LMT) tool that was developed at the University of Michigan in Ann Arbor was used to measure mathematics content knowledge of M^3P participants. This assessment measures teacher content knowledge in 1) number and operations, 2) patterns, functions, and algebra, and 3) geometry. Teachers have been administered the LMT as a pre-test. The post-tests were administered in the Summer of 2008 when teachers have completed the program. In the summer of 2007, at the end of the first year of the program, teachers were surveyed to determine if adequate resources and technology support were provided to them. Grant teachers participated in the first half of their methods training. They used various manipulatives to develop new lessons for the 2007-08 school year. One major component of this training involved the use of interactive whiteboards in the classroom. An interactive whiteboard is an

outstanding visual resource that can help teachers to present lessons in lively and engaging ways and can actively involve students in the lessons.

Additional training by Kenosha Unified instructional technology teachers has been provided throughout the school year to support teacher learning and practice within their classrooms. Teachers have also formed a study group which meets monthly to plan lessons, exchange ideas, and work with a trainer on the use of the interactive whiteboard. One of the most important effects has been the time to process, share, and reflect on the activities and how to incorporate them into the classroom.

Participants also shared how they have changed their lesson plans because of their increased knowledge. Teachers are beginning to see the connection between their college mathematics courses and their classrooms. Presently they are taking a Modern Geometry course and have commented that they now see the purpose for the lessons in their curriculum. The teachers have learned the importance of manipulatives and have incorporated them into their lessons.

During their summer methods training, teachers designed lessons based upon the following math standards: Probability and Statistics, Geometry, and Measurement. They used manipulatives and technology to become familiar with new ways to approach mathematical topics. The design of their lessons evolved from teacher presentation to student involvement in the learning process.

Baseline data related to student achievement is currently being collected. Results from the WKCE Fall 2006-07 have been collected and pre-program data has been documented for students in classrooms of program participants (experimental groups) and for the control group (students in classrooms teachers with the same educational background of participants but not in the program).

Student achievement was measured through the IAAT (Iowa Algebra Aptitude Test). This assessment is administered to students in grade 8 each year in January to determine grade 9 mathematics placement (regular or advanced). The results for 2006-07 indicated that 86.84% percent of students were prepared for advanced level mathematics next year.

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Laona Mathematics: Northern Wisconsin Rural Partnership for Mathematics Education

Est. 2005

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- Gilmanton School District
- Glidden School District
- Goodman - Armstrong School District
- Laona School District
- Nekoosa School District
- Niagara School District
- Nicolet Area Technical College
- Northwoods Distance Education Network
- Northwood School District
- Park Falls School District
- Phelps School District
- Plum City School District
- Tomahawk School District
- University of Wisconsin - Eau Claire
- Wabeno Area District
- White Lake School District
- Winter School District
- WASDI
- Wonewoc-Union Center School District

Abstract:

The Northern Wisconsin Rural Partnership for Mathematics Education is a collaboration to address the critical need to improve mathematics achievement of students. Our project applies research findings that student achievement increases when mathematics teachers have deep content knowledge of their subject (Killion, 1999, U.S. Department of Education 2002) and a repertoire of effective teaching strategies (Garet, 2001) that center on student learning (Garet, 2001; Lambert, 1998). The partnership provides opportunities for advanced and ongoing professional development activities that improve teachers' subject matter knowledge. The activities relate directly to the curriculum and subject area in which the teachers provide instruction, enhance the ability of teachers to understand and use challenging content standards, and provide teachers the opportunity to work with university mathematics professors. These opportunities and activities relate directly to the stated purpose of the Mathematics and Science

Partnerships, Title II, Part B. Mathematics professors from UW-Eau Claire who have considerable experience working with and in K-12 schools deliver 10 days of professional development institutes centered on the Wisconsin Model Academic Standards relevant to grades 3-8 in each of three summers. They also provide in-school consultative help in each teacher's classroom for 7 days. Ongoing facilitated electronic communication, both synchronous and asynchronous, encourages reflective dialog and ongoing collegial contact between staff and teachers. Participating teachers receive a stipend, expenses, and materials.

Our project is currently supporting 21 grades three through nine teachers of mathematics from the nine following school districts: Beecher-Dunbar-Pembine, Boulder Junction, Glidden, Laona, Northwood, Park Falls, Plum City, Wabeno, and Goodman-Armstrong. These districts were all on the High-Need LEAs list identified by the Wisconsin Department of Public Instruction. As a result of participation in this program these 21 grades 3-9 teachers will:

- Know mathematics necessary to teach mathematics at their grade level and beyond.
- Capitalize upon the connections between how mathematics is learned and the mathematics that is learned.
- Select appropriate rich mathematical tasks to exemplify and clarify important mathematical topics.
- Answer classroom questions that arise and stretch the mathematics covered by having competence and confidence in their own mathematical understandings.
- Make wise choices about classroom curricular materials that will truly implement a standards based classroom as a curriculum for all.
- Help students make sense of mathematics.

Teachers content knowledge gains were assessed with pre/post administration of the Content Knowledge for Teaching Instruments (Ball, et al). Teacher knowledge gain was connected to student achievement on Wisconsin Knowledge and Concept Examinations and through this approach demonstrated the worth of this particular regimen of professional development for teachers. Rural teachers have also reduced their isolation by establishing a network of colleagues in similar schools and by connecting online to these colleagues and mathematics professors. With a three-year project building ongoing competence for these teachers, and the presence of a team of three in each building, capacity is expected to grow as these more highly qualified teachers exercise leadership.

Introduction:

Historically, schools and teachers across Wisconsin and the nation have indicated that content knowledge of teachers in mathematics is a strong need for teachers of grades 3 through 8 (WASDI, 2002). Teachers also have identified the need for time and assistance for collaborative study and more opportunities to interact with teachers outside their district. Specifically for this project, WASDI staff met with several administrators from targeted districts before the Title II, Part B, grants meeting in Wisconsin Dells on June 7, 2005, who confirmed these needs. One partner in this project, the Northwoods Distance Education Network (NDEN) currently is conducting staff development for teachers in several of the targeted schools. The director of this project, Ginny Metzdorf, interviewed many of the administrators not attending that meeting and confirmed these needs. E-mail and phone conversations with administrators have borne out the need for content enhancement and time and assistance for collaboration. These administrators also requested that the grade range be 3-8 as these are tested grades starting in Fall, 2005.

The project targets schools that have specific needs as identified by data from WINSS, interviews with school administrators, and school district internal data. Specifically, schools with significantly high levels of economically disadvantaged students and schools with significantly high numbers of students scoring at the minimal or basic levels on the Wisconsin Knowledge and Concepts tests at 4th and/or 8th grade have been invited to participate and have joined the project as partners.

Data Analysis:

The schools involved are small, rural school districts that have a history of very low levels of professional development for teachers. The typical school district is a single section per grade elementary district. This creates opportunities and difficulties. Some data collection and reporting is difficult because data reported by grade is actually reported by teacher (single teacher per grade). Geographic distance is great which complicates the in-school work portion of the project. However, the teachers are very appreciative of the opportunity for this learning and are making great strides.

Content knowledge growth is being assessed at regular intervals using the University of Michigan developed and normed Content Knowledge for Teaching Mathematics Measures. While it is early to assess real growth until more intensive study of each standard occurs, the evaluation section addresses the early findings. Observational/interview approaches to instructional change based on this professional development also have occurred three times over the year. Regular contact is also made via e-mail and through messages left on the online conferencing system through which all of the participants are connected. These documentations of teacher growth also are in the evaluation data.

A particularly rewarding, though difficult, part of the project has been the in-school consultations. This allows for individualization of the instruction to the needs of that grade level and that teacher. It is possible to address the situation of the teacher also. Different schools use vastly different curricula and whether these materials need to be honored or adapted is hugely different from school to school. This in-school portion is a very valuable component to the project. The teachers also need their support mechanism from each other, however, and this individualization does not present opportunities for their summer bonding to re-connect. The online component is supposed to compensate for this and has been useful but needs to be strengthened.

Goals and Objectives:

Goal 1: *Know mathematics necessary to teach mathematics at their grade level and beyond.*

1. Progress is being made, observable through class observations. This was assessed through the Content Knowledge for Teaching Mathematics Measures.

Goal 2*: Capitalize upon the connections between how mathematics is learned and the mathematics that is learned.*

Goal 3: *Select appropriate rich mathematical tasks to exemplify and clarify important mathematical topics.*

Goal 4: *Answer classroom questions that arise and stretch the mathematics covered by having competence and confidence in their own mathematical understandings.*

2-4: University mathematics professor charged with the instruction both in the summer and in-school is documenting good success through classroom observation of the teachers in action and the fulfillment of their change plans.

Goal 5: *Make wise choices about classroom curricular materials that will truly implement standards based classroom as a curriculum for all*.

5. The foundation for decision making in content enhancement has begun, observable in schools.

Goal 6: *Help students make sense of mathematics.*

6. Begun. Observable in classes and also online discussions.

Program Plan: 21 participants – 2 credits per week for summer institute, 4 total.

Evaluation and Reflection:

The outside evaluator is Dr. Marge Wilsman of the Wisconsin Center for Educational Research at UW-Madison. Dr. Wilsman gathered baseline, formative, and summative data to measure progress on program objectives.

Dr. Wilsman and Dr. Sparks have recently been trained at the University of Michigan to be able to administer the Content Knowledge for Teaching Mathematics Measures developed by Deborah Ball and her associates. These measures have been normed through repeated use in-scale projects and correlated with student achievement. There is a large research base behind the development of the measures, and this was used fully through this project. Teachers were given alternate forms of the measures as a pre-assessment and annually throughout the three years. Each participating district made WKCE data available for Dr. Wilsman to analyze. The district partner not sending teams of teachers to the institute and not receiving the other services of the project served as a control group to compare growth over time.

Assessable Project Goals:

Teacher participants significantly increased their knowledge of mathematics content as measured by the Content Knowledge for Teaching Mathematics scales. This instrument was administered anonymously to participants before the instruction and alternate forms were given annually thereafter. Data was analyzed by the outside evaluator to assure confidentiality of results. The analysis allowed growth of teacher content knowledge to be measured. Results were provided to project staff to use in program design as general findings, not by individuals. This allowed for interpretation of post-test data without contamination with "teaching to the test."

Students of teacher participants increased their scores on the WKCE-CRT each year of the project; that is, the same student's score will increase in subsequent years. Average scores of students on the WKCE-CRT increased for individual teachers over the years of the project; i.e., each year's students of an individual teacher scored higher.

Teacher participants rated their ability to address important issues of teaching significant mathematics with understanding as higher post participation. The outside evaluator constructed survey forms to assess self-perception and attitude variables. This data was used formatively to guide successive years of the project and summatively to look at teacher confidence in their abilities. Students in comparable schools

(also on the high need list) whose teachers do not participate in the project showed less growth on the WKCE-CRT than the students in schools where their teachers participate in the project.

The outside evaluator conducted appropriate statistical analysis of scores for participating and non-participating districts. Surveys were conducted to find the level of staff development received by control group districts.

Many of the participating districts have few if any teachers in grades 3-8 who even occasionally participate in mathematics content-based staff development session. This program allowed teams of teachers to have content enhancement targeted to their teaching need with continuity over time.

The course syllabus, online discussions, and in-school consultations were targeted at the growth of the content knowledge necessary for the teaching of mathematics in grades 3-8 as described in the Research section under the work of Deborah Ball. The assessment tool for teacher learning has also been designed by Ball and Associates to indicate level of knowledge in this usable context. This strong body of research was used both in assessment and program design. In a large study in California (Hill, et al, 2005) of schools engaged in instructional improvement initiatives, it was found that higher teacher scores correlate positively with higher student achievement scores. This guiding philosophy used the prior knowledge from the research to design the program with anticipated similar results and add to the database for this research. Future programs can then benefit even more from the results that are being replicated in many projects around the country, particularly large-scale MSP projects funded by NSF.

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- Nicolet Area Technical College, Rhinelander
- Northwood School District
- Siren School District
- University of Wisconsin - Barron County
- Wabeno Area School District
- WASDI

Abstract:

The Northwest Wisconsin MSP-Science was a targeted program for teachers of physics in rural areas. The project provided 26 days of professional development sessions led by university scientists, experienced master teachers of high school AP physics, and industrial engineers. Seventeen teachers from fifteen districts participated. Participants were involved in lectures and lab activities using state of art electronic equipment. All participants developed, evaluated, and shared classroom demonstrations relating to specific physics concepts. Graduate credit was available.

Introduction:

Needs were identified by the Department of Public Instruction by an analysis of student achievement data. DPI found that "the data also shows that high school chemistry and physics teachers need training in order to increase the student achievement in chemistry and physics, particularly in rural school settings." The resultant Request for Proposals specifically targeted this group. The need for physics content, pedagogical content knowledge, and the opportunity to interact with colleagues was confirmed through a WASDI statewide needs survey (4, 279 with a 32% return) and two focus groups.

Goals and Objectives:

The overall purpose of the Northwest Wisconsin MSP – Science project was to increase the effectiveness of physics teachers in working with students. Goals were to 1) increase participant content background in physics; 2) increase participant repertoire of standards-led and tested lab activities and demonstrations; and 3) establish a collegial and lasting relationship among and between participants, university scientists, engineers, and master teachers.

Program:

The Northwest Wisconsin MSP – Science was a targeted program for high school teachers of physics. The objectives of the project were to 1) increase participant content background in physics as evidenced by pre-post tests, surveys, and indirectly by credits earned during 26 days of instruction. This was deemed as accomplished by an outside evaluator; 2) increase participant's repertoire of standards-led and tested lab activities and demonstrations as evidenced by a minimum of 15 collaboratively developed and conducted activities. This was accomplished with activities presented, critiqued, and shared on CDs and videos, and by presentations at the Wisconsin Society of Science Teachers (WSST) Annual Convention by all participants; and 3) establish relationships among and between participants, university scientists, and master teachers. This was accomplished as evidenced by participant surveys and by participation in the Wisconsin Science Network, NSTA memberships, and participation at the WSST annual conference.

The first two week summer session was held at University of Wisconsin-Barron County. A school year weekend session was held at the University of Wisconsin-Madison nuclear reactor lab, and another weekend session was held in conjunction with the WSST conference for paper presentations and interaction with other science teachers. The second two week summer session was held at Fond du Lac High School in their state-of-the-art physics laboratory. All sessions involved university scientists and master teachers. A day-long session with engineers from Mercury Marine stressed physics application in industry. A day-long session with engineers at Fond du Lac High School related physics to the geothermal heating and cooling of the very large building.

Sessions were characterized by formal presentations by university scientists and pedagogical applications led by a master teacher. Participants were engaged in lab activities, including using Logger Pro 3 that was provided. Demonstrations and the development of new lab activities were an integral part of each day.

Participants could earn 2-4 credits each summer for their work. Over the two summers (four weeks), seventy-five percent of the participants took the course for graduate credit (Educ 784 Teaching Physics – A Review). Seventy-eight graduate credits were awarded through Viterbo University.

Evaluation and Reflection:

The evaluation of the Northwest Wisconsin MSP – Science program was designed to provide ongoing formative evaluation for program improvement and a summative evaluation of the project goals. Summative evaluation questions, based on the stated project goals, were:

- Did the participants increase their knowledge of physics concepts?
- Did the participants increase their effectiveness in working with students?
- Were professional relationships and networks established?

Content Knowledge:

Participants increased their content knowledge of physics. While all participants were certified teachers, there was considerable difference of background content knowledge and experience. A pre-post self reporting survey of nine physics content areas indicated significant increase in self rating of knowledge. Within the nine areas, three (kinematics, forces, kinetic theory) received special emphasis during the project. This emphasis was reflected in a 30% increase in the pre-post response of high knowledge.

The Force Concept Inventory was administered pre and post. An average normalized gain was used to analyze the data; $(g)=((S_{post})-(S_{pre})/100) - (S_{pre})$. Research conducted by Hake in 2001 found that in 48 interactive–engagement survey courses g=0.48 while in traditional courses the normalized gain was 0.23. In this project the normalized gain was 0.5. This project was deemed highly interactive and heavily engaged the participants.

Effectiveness in Working with Students:

Participant pre/post self reporting provided an indication that skills associated with classroom effectiveness increased. This was especially significant in mathematical modeling of data, misconceptions in physics, graphical analysis, and use of probeware. All participants reported that the quality and quantity of use of proven demonstrations increased.

Professional Networks:

The development of professional networks was considered one of the greatest accomplishments of this project by the evaluator, the staff, and by the participants. All participants became members of NSTA and attended and presented papers at the WSST Annual Conference. None had previously attended, and none had ever presented a paper at a professional organization. All participants became part of the Wisconsin Science Network and have continued to remain active.

Formative Evaluation:

Formative evaluations based on surveys and observations were conducted daily during the summer sessions and at the end of each weekend session. All formative evaluations were shared with staff. All session activities were perceived as valuable by the participants. Of highest value were the opportunity to share, the work in the lab, and the class discussions.

Three program changes took place based on formative evaluations. 1) In response to the evaluations that the course appeared disorganized, a daily detailed schedule was printed and distributed. 2) A major issue was the presentation of mathematical modeling that was not at the level that the majority of students could understand. This was addressed by reducing the amount of math and by adding a historical discussion of the development of the model.

Another activity worthy of mentioning was web-based learning; specifically “Force and Motion.” The participants were asked to complete and review the beta version of Science Objects. Science Objects was developed by NSTA with funding from NASA, NSF, and other sources. Al Beyers, the Project Director, visited and interviewed participants. There was general participant dissatisfaction with the time it took, but evaluations and comments indicated it was a valuable experience, and many reported that it did increase their content knowledge. They also reported that it made them feel they were on the “cutting edge” of a program and they could (and did) make a difference.

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Milwaukee Public Schools: Project CLASS

Est. 2005

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Partners:

- Alverno College, Milwaukee
- Milwaukee Partnership Academy
- Milwaukee Public Schools

Abstract:

Project CLASS is a three-year professional development program offered at Alverno College for Milwaukee area science teachers in grades 5-12. The project addresses two interrelated problems endemic to science learning in the U.S.: 1) declining levels of science achievement and attainment, and 2) competency gap (content knowledge) for those providing instruction. Participants engage in graduate level coursework, self-directed action research projects, cohort activities, on-site mentoring and coaching, interaction with school learning teams, and professional networking.

Introduction:

In response to an expressed demand by the Milwaukee Public School District (MPS) science teachers and supported by data-based evidence, there is a need to provide professional development for science teachers, grades 5-12. MPS's student achievement in science has continued to be significantly lower than the state average over the past three years and shows a declining pattern. Current data indicate that only 44% of MPS fourth grade students, 34% of eighth grade students, and 28% of tenth grade students were proficient in science on the 2006-2007 WKCE. More significant is the drop in proficiency from the elementary level to middle school and likewise the drop from middle school to high school. MPS students lag behind Wisconsin state averages by 30-41 percentage points, with the biggest gap at the 10^{th} grade level—50 percentage points. The student achievement gap between the district and the state is widest in the area of science.

Teachers in MPS are simply not well prepared for teaching science. According to a survey of 5^{th}-12^{th} grade science teachers conducted by MPS in 2003, 61% of teachers surveyed had neither a major or minor in science. The survey was repeated in spring 2007 and yielded a similar response from district teachers; more than 50% responded that they had not participated in any form of professional development, graduate courses, or specialized programs in science in over five years. Data collected through informal and formal discussions with district teacher groups revealed that new and inexperienced teachers, especially those who lacked a content-rich background in science reported difficulty in creating and teaching standards-based lessons and developing appropriate classroom assessments to determine student achievement. Moreover, many elementary and middle grades teachers are assigned to teach science without sufficient background. The survey revealed that the majority of teachers at these levels felt "uncomfortable" teaching 11 out of 14 topic areas within the science standards.

Many MPS teachers report that they struggle to align the district's learning targets to their curriculum content and rely heavily on textbooks and worksheets that provide little support for in-depth learning. The

teachers also indicated a strong need to learn to develop appropriate assessments to meet the learning targets. District survey results (2003 and 2007) indicate that fewer than 22% of grades 5-8 science teachers use classroom data more than twice a month to guide or modify instruction. A sampling of district teachers from grades 5-12 who participated in the online Surveys of Enacted Curriculum for Science (SEC) in 2005 and 2007 revealed that nearly 50% of these teachers lacked the readiness to teach or to assess student learning in standards-based science content.

Goals and Objectives:

The goals of the project are: 1) To increase the science content and pedagogical knowledge of middle grades science teachers to improve teaching and learning; 2) To increase teachers' use of standards-based assessments aligned to district learning targets and classroom instruction to improve teaching and learning; and 3) To develop participating teachers into emerging leaders of science to expand district leadership to promote professional development in support of effective teaching and learning in science.

Program Plan:

Provide information related to project work plan, number of participants, completed coursework including number of credits, certificates, or degree awarded, and other relevant activities. The program offered six courses (18 graduate credits) over three summers (2006, 2007, and 2008). In the first summer, teacher participants from MPS and other area districts and parochial schools, focused on inquiry-based science teaching and key themes of science, aligned with the Wisconsin Model Academic Standards. During the school year following the first summer, teachers participated in on-line discussion groups and meetings on campus; they were provided with retired teacher mentors, who visited their classrooms and provided feedback on their ongoing reflections. Then they presented an action research report to faculty members and district science teachers in April. During the second summer, teacher participants took a second set of courses, with similar follow up during the year; they presented action research projects in March, 2008. Finally, in the third summer, they took courses focusing on assessment in the science classroom and mentoring fellow teachers in improving science instruction. During the year following the third summer, they were invited to be part of the planning and implementation team for in-service activities held by the district.

Evaluation and Reflection:

The project is using both a project-created pre- and post-test to determine science content knowledge of teachers as well as the survey instrument created by the Council of Chief State School Officers (CCSSO), the Survey of Enacted Curriculum (SEC) in Math and Science, which offers a practical method for collecting, reporting, and using consistent data on instructional practices and subject content taught in classrooms—as a partial measure of the direct impact of the professional development and mentoring activities. The instruments are being completed at entry and at the mid-session of the third year of the program by the participating teachers and a matched control group drawn from other MPS science teachers. This analysis provided a systematic comparison of teacher changes in curriculum applications for those participating and other district teachers; the SEC data were analyzed for changes over time between groups.

Assessment and surveys completed by the participating teachers in the development activities and records from the mentors provided an additional source for formative evaluation. With the help of the

SEC research staff, a specialized comparative report was prepared to analyze changes in the participants' application of standards in curriculum and assessment over the course of the project.

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Nekoosa: Community of Mathematics Learners
Est. 2005

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- Nekoosa School District
- Silver Lake College, Manitowoc
- Westfield School District
- Wisconsin Dells School District
- Wonewoc-Union Center School District

Abstract:

A total of five rural and high poverty districts located in central Wisconsin - including Almond-Bancroft, Nekoosa, Westfield, Wisconsin Dells, and Wonewoc-Union Center - have joined forces to develop this project, entitled Community of Mathematics Learners. All are included as eligible districts on the WDPI's High Need list for this program. These districts serve 5,464 students in grades K-12. Our project targeted the needs of more than 1,500 public and private middle school students and upwards of 35 educators who teach math across 6-8. Need for this project is based on low student achievement and the need for more effective teaching in math. In fact, the percentage of students who achieve proficiency on the WI Knowledge and Concept Exams (WKCE) for Math reaches a low 46% across the consortium, with a dismal average of only 62%. Teachers indicated a strong need for professional development focused on providing more in-depth knowledge of the state mathematics content standards, as well as improved instructional and assessment strategies that better address the diversity of learners, increasing parental involvement in math education is also seen as a high priority. To address identified needs, we have developed a high quality and sustainable professional development program in partnership with the Mathematics and Education Department of Silver Lake College (SLC) that closely linked to the PI-34 teacher standards and *Wisconsin's Model Academic Standards for Mathematics*. Our program utilizes scientifically-based research and best practices in mathematics and professional development.

Introduction:

Overwhelming need for this project is based on historically low student achievement in mathematics across the consortium, and the consequent need to improve mathematics teaching and learning, as described next.

1. Low Student Performance: Results from the 2003-04 WKCE indicate that an alarming percentage of students across the CML consortium are failing to grasp the content and skills set forth in the WMAS for Mathematics for Grade 8. In fact, as shown in the following table, the percentage of students who achieve proficiency reaches a low of 46% across the consortium, with a dismal average of only 62% - a figure significantly lower than the state's average of 65%.

Percentage of 8th Graders Scoring Proficient or Above on WKCE for Math (2003-04)						
Almond - Bancroft	**Nekoosa**	**Westfield**	**Wisconsin Dells**	**Wonewoc-Union Center**	**Consortium Average**	**Statewide Average**
66	46	61	60	80	62	65

It is also very disturbing to note that performance on the WKCE in math drops drastically between grades 4 and 8 among consortium students. For example, in 2003-04 the average percentage of students who scored at or above proficiency dropped from 80% in 4th grade to 62% in 8th grade! This reflects the findings of the recent Third International Mathematics and Science Study (TIMSS) that found American 8th and 12th graders perform lower than the international average in mathematics, and that achievement drops significantly between grades 4 and 8 among American students. Adding to this distressing information is the fact that students who are typically underrepresented, such as students with disabilities or living in poverty, have significantly lower achievement levels than their peers, as documented in the following 2003-04 WKCE results in math for consortium 8th graders. A mere 7% of students with disabilities were able to achieve proficiency compared to 65% of non-disabled students (in those districts with disability reports on WKCE). Only an average of 41% of economically disadvantaged students achieved proficiency compared to 62% of non-disadvantaged peers (in those districts with economically disadvantaged reports on WKCE).

These figures are extremely critical given that several consortium districts have a greater concentration of students who are of ethnic minority status and/or receiving special education services compared to the statewide averages. For example, roughly 18% of all consortium students are special education compared to 12% across the state; upwards of 12% of Almond-Bancroft students are Hispanic compared to 6% across the state; and both Wisconsin Dells at 8% and Nekoosa at 3% have higher percentages of American Indian students than the state as a whole at 1.4% (WINSS). Clearly, drastic measures need to be taken to close the achievement gap so all students can acquire the skills, knowledge, and confidence to become proficient math learners.

2. Need for Improved Instruction: According to EDThoughts: What We Know About Mathematics Teaching and Learning (2002), researchers from Mid-continent Research and Learning (McREL) state: "One of the strongest predictors of students' success is the quality of their teacher…High quality and effective teachers have a deep understanding of mathematics content knowledge, content skills, effective instructional strategies, and confidence in decision-making." Unfortunately, according to researcher Susan Loucks-Horsley in *Ideas that Work: Effective Professional Development for Teachers of Mathematics*, "many teachers enter the classroom unprepared to teach challenging mathematics." This is especially true among middle and high school teachers who are teaching out of their areas of expertise. In fact, a survey of the teachers targeted for this project found that only 42% possess either a math minor or major. Teachers' lack of preparation becomes even more critical in light of state and national mathematics standards which call for the teaching of more challenging mathematics.

To gain a clear picture of teachers' needs relative to mathematics teaching within the consortium, we recently conducted a needs assessment among all teachers in grades 6-8 targeted for this project. The top three areas related to mathematics instruction teachers want more training in are:

1. Applying an array of strategies to effectively instruct all students, including those with diverse needs;

2. Using strategies to develop student conceptual understanding; and
3. Using multiple methods to assess depth of student understanding and drive instruction.

Fully, 77% of teachers felt that parent involvement in their child's math education needs to be improved.

The survey also found that 40% of these districts are not utilizing the more challenging, standards-based curricular resources developed to address the National Council of Teachers of Mathematics Standards, and subsequently funded by the National Science Foundation, such as Everyday Mathematics or Connected Math Project. Additionally, the survey found that only 41% of teachers spend more than 45 minutes a day in math instruction, while nearly 30% spend 40 minutes or less. Pursuant to this, 41% of teachers indicated that math is not integrated into other curricular areas. In *Planning Curriculum in Mathematics* (WDPI, 2001, p. 169) researchers state, "To adequately achieve the goals and standards established for middle-level mathematics and have them taught in meaningful ways to students, appropriate time allocations must be provided. No longer can a 35- or 40-minute class period per day adequately allow teachers and students to achieve the challenging curriculum as outlined in current standards. Longer class periods were required."

Results from the needs assessment process point to the dire need for immediate measures to improve both teacher and student mathematics proficiency. While a number of substantial needs have been identified, our project focused on the priorities of increasing teachers' in-depth knowledge and understanding of the WMAS for Mathematics, improving instructional (pedagogical content knowledge) and assessment skills related to the standards, and increasing parental involvement in math education. Other needs identified by the needs assessment process (such as more challenging math curriculum, math instruction time, curricular integration, etc.) would be included in partnership activities as part of project continuation strategies after funding terminates. The CML consortium feels strongly about focusing on the most pressing needs through this project and keeping the partnership intact to continue addressing needs after MSP grant funding ends.

Goals and Objectives:

Goal 1: *To improve the academic achievement of students in mathematics across grades 6-8*.

Objective 1.1: The percentage of students in grades 6-8 who score at "grade level" or above, and meet age appropriate performance benchmarks as per the WMAS for Mathematics as appropriate for their grade level increased on average by 3% by May 2007, and by at least 6% by May 2008, compared to baseline data.

Objective 1.2: The percentage of 6th-8th graders who score at or above the proficient level on the WKCE in mathematics increased by 3% on the 2006-07 WKCE and at least 6% on the 2007-08 WKCE compared to baseline data.

Goal 2: *To enhance the math content knowledge and teaching skills of classroom teachers in grades 6-8.*

Objective 2.1: To increase the number of teachers participating in content-based professional development, at least 90% of targeted teachers participated in the following "Work Plan" activities: 1) Year 1: "Kick-Off" Math Summit and 2006 Summer Institute (or equivalent on-line learning); 2) Year 2: 3 math conferences, 2 classroom observations and follow-up seminars, action research, study groups, and 2007 Summer Institute (or equivalent on-line

learning); and 3) Year 3: 3 math conferences, 2 classroom observations and follow-up seminars, action research, study groups, and 2008 Summer Institute.

Objective 2.2: During each project year, at least 95% of teachers who participate in math standards-based professional development activities as per the "Work Plan" will increase their mathematics content knowledge by at least 5 points as measured by pre and post specific course content tests and/or an instructor identified standardized math content assessment.

Program Plan:

Math Conferences [teacher standards 1, 5, 6, 8]: During each school year (years 2 and 3), SLC professors held a total of three, 8-hour math conferences for all targeted teachers as a group to provide follow-up training and support on the material covered in summer institutes. The entire consortium attended each bi-monthly conference and districts took turns hosting the conferences. Teachers received more in-depth training on instructional and assessment strategies, and worked with teachers in setting up and implementing their action research projects. Teachers were also required to share their experiences with the group as they implement strategies in the classroom previous to each conference, as well as findings from action research projects.

Classroom Observation and Follow-Up Seminars [teacher standards 1, 3, 4, 5, 10]: SLC instructors conducted classroom visits to all targeted teachers once a semester in years 2 and 3. Instructors modeled and coached best practices, and observed teachers' implementation of classroom strategies learned at the summer institutes and math conferences. At the culmination of classroom visits, professors held follow-up seminars with all targeted teachers in each district to discuss their findings and evaluations. This also provided a platform for furthering modeling, coaching, group discussion, networking, inquiry, and study.

Action Research [teacher standards 1, 2, 3, 8, 10]: Teachers were trained in action research and required to develop a research project during years 2 and 3 focused on specific instructional strategies. Teachers gained two graduate credits for each action research project (totaling four credits during the project).

Study Groups [teacher standards 1-10]: Districts held on-site monthly study groups for teachers as a platform for continued collaboration, coaching, networking, and support – to be facilitated by each district's site coordinator and/or math leader. Counselors, administrators, and parents were invited to these sessions.

On-Line Learning [teacher standards 1-10]: SLC developed a website as a resource for teachers for continued support, networking, and training on the topics presented in institutes/conferences. The site posted resources and lesson plans, and featured a chat line, discussion board, and group e-mail. Coursework covered in Summer Institutes is available on-line for teachers who could not attend, or new/ other K-12 teachers.

Parent Education [teacher standard 10]: Each district promoted parent involvement by: 1) inviting parents to the "Kick-Off" Math Summit, Summer Institutes, and Study Groups; 2) inviting parents into math classrooms to observe and/or volunteer; and 3) holding annual Family Math Nights focused on educating parents on the components of this initiative, providing opportunities for parents to engage in math activities with their children, and providing training and resources for parents on how to help their children with schoolwork.

Evaluation and Reflection:

We implemented a thorough evaluation of our project throughout the program's duration appropriate to its goals, objectives, and proposed activities. Both an internal and external evaluation took place. An internal evaluation was conducted by the Project Director, with assistance from the Steering Committee. Janet Kempf-Vande Hey, M.S., an expert evaluation and research consultant from JVK Research experienced with experimental evaluation design provided an unbiased, professional external evaluation (see resume in Appendix C). Together, these individuals measured success and effectiveness of program implementation strategies, and evaluate the attainment of the program goals and objectives.

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Racine: Preparing Outstanding Science Educators Project (POSE)
Est. 2005

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- University of Wisconsin - Parkside

Abstract:

The Preparing Outstanding Science Educators Project (POSE) is a partnership between the Racine Unified School District (RUSD) and the University of Wisconsin-Parkside (UWP). The partnership was formed to develop a program of staff development that concentrated on 20 elementary educators and provided them with standards-based content instruction in Earth, Life, and Physical Science (six credits) as well as effective teaching strategies within the context the elementary educators taught science (six credits). UWP science faculty taught the content courses. The Center on Community Partnerships at UWP provided instruction in classroom management and pedagogical techniques of teaching science. These activities are in line with the stated purpose of the Mathematics and Science Partnerships, Title II, Part B as well as PI 34. The POSE Project is predicated on research findings that indicate staff development has a greater effect when small groups receive professional development over an extended period of time where content, technique, and context are integral components of the program. The one-year program allowed the participants to form a professional and collegial group that will enable participants to reflect and provide feedback to all members. Participant educators were be paired with pre-service educators from the UWP in a mentor – mentee relationship with the placement of the preservice educator in the participant educator's classroom. Project goals are to:

1. Improve science test scores on the Wisconsin Knowledge and Concepts Exam;
2. Improve elementary science educator content knowledge and understanding of research-based pedagogical techniques;
3. Develop a professional learning community within the RUSD;
4. Develop mentoring techniques and abilities within district educators and foster relationships with pre-service educators; and
5. Develop and improve science classroom management techniques.

The anticipated effect of the project was:

1. Students taught by participant educators science test scores were greater than those taught by nonparticipant; and
2. Students' perceived attitudes towards science would improve.

Participant educators will:

1. Achieve a higher level of science content knowledge;
2. Gain insight into research-based pedagogical techniques and improve their ability to engage children in learning;
3. Develop a professional learning community; and
4. Increase their confidence in teaching science.

Introduction:

Over the past seven years the Public Policy Forum, an independent research academy, has conducted a Comparative Analysis of RUSD. The analysis has compared RUSD with nine peer districts in the State of Wisconsin as well as Milwaukee. The Milwaukee School District is almost four times as large as the next largest district in the state, third is RUSD. Only four of the peer districts' enrollment exceeds 20,000 students. Data from the 2003–2004 State of Wisconsin School Performance Report was used in the analysis. Results from the 2003–2004 WKCE indicated that the district fell short of the 65% threshold of all students being proficient or advanced in science at all three grade levels tested.

The district has consistently ranked last in fourth, eighth, and tenth grade reading and math scores in comparison with peer districts. Scores drop significantly as students age. By tenth grade, 42% of all students ranked below proficiency in reading and 45% were below proficiency in math. Census 2000 data indicate that over 39% of all individuals over the age of 25 in CT1-5 do not have a high school diploma or other credentials.

Each entity in the POSE Project has similar yet different needs. Both have the need to provide more efficient and effective instruction/staff development for their respective staff and students thereby increasing their success. RUSD must continue to show academic progress as specified by the No Child Left Behind Act (NCLB) of 2001. The requirement to show academic progress necessitates improvements in teaching techniques and content knowledge to enable educators to engage students in the act of learning at a young age. This is particularly true in the case of Initial Educators and requirements of PI 34. The UWP as an institution of higher education (IHE) has the need and mandate that students attending UWP succeed after graduation.

Goals and Objectives:

The goals of this project are:

1. To improve student test scores in science and student perception of science in grades K–5;
2. To improve elementary science educator content knowledge and understanding of research-based pedagogical techniques;
3. To develop a professional learning community within RUSD;
4. To develop mentoring techniques and abilities within RUSD educators and foster relationships with UWP pre-service educators; and
5. To develop and improve science classroom management techniques.

Objectives:

Students:

1. Fourth grade students taught by the experimental group of elementary educators will outperform students from the control group as measured by science test scores on the November 2007 WKCE.
2. Students' perceived attitudes towards science would improve measured by a pre-test, post-test design.

Participant Teachers:

1. Achieve a higher level of science content knowledge in their field.
2. Gain greater insight into research-based pedagogical techniques to improve their ability to engage their students.
3. Develop a professional learning community within RUSD for elementary educators.
4. Elementary science educators will develop the ability to mentor pre-educators.

Program Plan:

The POSE program worked with 21 elementary teachers of which 20 completed the entire program. At their option, they could register for 12 college credits associated with the program.

The following courses and subjects were included in the program:

Life Science – 1 credit
Earth Science – 1 credit
Physical Science – 2 credits
Fundamentals of Science – 1 credit
Techniques of Science Instruction – 2 credits
Reflection and Extension of Summer Institutes – 1 credit
Implementing Science Strategies – 1 credit
Management of an Elementary Science Classroom – 1 credit
Supervision of a Student Teacher – 1 credit
Contextual Instruction – 1 credit

Evaluation and Reflection:

The POSE Program was based on a quasi-experimental design. The comparison group study compared outcomes (specifically student achievement for an experimental group of third-grade students with outcomes for other Third-Grade students within the same school building not receiving the same programs and/or activities to the experimental condition).

An attitudinal comparison of students in experimental and control classrooms also demonstrated a significant positive impact of the program on the way students view science. Teachers began the program in the spring of 2006. They completed their activities in the spring of 2007. Student achievement on the WKCE was compared in the spring of 2008 between students of program participants and those who did not participate in the program. There has also been an effect of the program on teachers. Pre- and post-test

results clearly demonstrate increased content knowledge by the program participants. Knowledge gains ranging from 24% - 65% were found on the four assessments administered. The average gain was 37%. Participant teachers have also been much more comfortable acknowledging what they know and what they do not know. The number of phone calls received by the elementary science coordinator requesting help, resources, and direction in new projects they were planning evidenced this.

Literature Review:

The following sources were used in the preparation of the POSE project:

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Superior: Superior Science Teachers
Est. 2005

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Partners:

- Bayfield School District
- CESA 12
- Drummond Area School District
- Glidden School District
- Hayward Community School District
- Mellen School District
- Northland College, Ashland
- Northwood School District
- Superior School District
- UW - Superior, Research Institute
- Winter School District

Abstract:

A partnership between Northland College, the School District of Superior, and CESA 12 sought to increase the knowledge of middle school science teachers from northern Wisconsin who served students with identified barriers such as poverty, low achievement, and isolated rural locations. The goal of the project was to address the themes of earth science, physical science, and the nature of science in a hands-on learning environment centering around the Lake Superior environment. Desired outcomes included increased knowledge for teachers, incorporation of new content into middle and high school curricula, and greater alignment between classroom content and the *Wisconsin's Model Academic Standards for Science*.

Introduction:

Students in northern Wisconsin are socially and economically isolated and live in communities with relatively low numbers of college graduates. They have limited exposure to personnel who work in science, engineering, or technology. Science teachers need to learn new content, research-based strategies, and how science supports public policy decisions. This grant was designed to address these needs.

CESA 12 participant schools vary widely in their demographics. At the time of grant application, the team studied the statistics for students in grades 6, 7, and 8 in eight school districts within the CESA, a total of 2,213 students. Poverty rates and college graduation rates for these communities indicate high needs exist; in addition, seven of those school districts were considered to be rural. Six of the eight districts had grade 8 science WKCE results that were below the state average of 74% proficient or advanced.

Goals and Objectives:

Program objectives for teachers included:

1. Develop a deeper understanding of *science content* that relates to regional features.
2. Integrate the principles of the *nature of science* into classroom curriculum.
3. Develop *congenial collegial relationships* with peers and with higher education faculty.
4. Identify and use *local resources* for project-based learning and enrichment.
5. Develop opportunities for participants to demonstrate *integration of new knowledge* into their classroom curriculum.
6. Use backward design to *develop curriculum* that addresses *Wisconsin's Model Academic Standards for Science*.
7. Increase the repertoire of *instructional strategies* used by participating teachers.
8. Design effective *project-based learning*.

Program objectives for districts included:

1. Improve *student achievement* as measured by the grade 8 WKCE and other assessments.
2. Improve the *alignment of middle school science curriculum* with *Wisconsin's Model Academic Standards for Science*.
3. Increase the number of high school students choosing to *enroll in upper level elective science classes*.

Program Plan:

Four one-week workshops were held in the summer of 2006 and 2007. The first two workshops, one in June and one in August of 2006, included a focus on broad context and content. The second two workshops in June and August of 2007 were centered around specific case studies and human impact. During the 2006-2007 academic year, three day-long workshops were held to design curriculum and increase participants' pedagogical skills.

Originally, grant organizers hoped for a total of 24 participants from the eligible districts. Participation did not reach this level. Some participants registered initially but then dropped out in the middle of the series (due to changing family needs and required travel). Because space was available and content was flexible, other teachers were allowed to register for the second round of workshops in 2007. Seven teachers completed the entire series; a total of 12 teachers participated in the project from start to finish. Several chose to complete the course for credit from Northland College.

Evaluation and Reflection:

All participants were surveyed at the beginning of the workshops and again at the end. In the pre-intervention survey, information about demographics, attitudes regarding teaching and learning, teaching practices, scientific background, and past professional development experiences was collected. The post-intervention survey addressed similar factors, and a comparison was generated. Relevant artifacts, such as curriculum units and lessons that were designed, were collected and reviewed.

Overall, participants reported an increase in content knowledge and increased comfort with high-impact instructional strategies. All participants reported either formally or anecdotally that their knowledge and understanding of *Wisconsin's Model Academic Standards for Science* also increased.

Participants also indicated that the hands-on nature of this experience was of great benefit to them, as was the opportunity to network with colleagues from other districts. Teachers in small districts often find themselves as a 'department of one' with many preps throughout the day; the collegial exchanges were especially helpful to these participants.

Specifically, the participants also reported a greater degree of knowledge about the geology of the local area, and learned a great deal from the field trips and from the variety of science experts made available to them throughout the two year period.

Literature Review:

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Green Bay: Mathematics Partnership
Est. 2006

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Partners:

- Green Bay Area Public School District
- St. Norbert College

Abstract:

The Green Bay Area Public School District (GBAPS), a high-need LEA with schools identified for improvement, and St. Norbert College in nearby DePere, a liberal arts and sciences institution, collaborated to develop a series of three graduate-level professional development courses, grounded in math reform, together with several linked supporting strategies. Emphasis for the course offered during summer 2007 was placed on strengthening teachers' understanding of math content. The second course, presented throughout the 2007-2008 school year, highlighted successful instructional strategies and alternative assessment techniques that could be implemented in participants' classrooms. During this school-year pedagogy course, teachers were expected to share their experience, learning, knowledge with other teachers in their buildings. The third course, offered during summer 2008, focused on application of math concepts to the world of science.

This project helped deepen math content knowledge of participating teachers, especially those at the elementary level who are generalists least likely to have a math-oriented academic background. Teachers' classroom instructional techniques were video recorded for self-analysis and guided reflection with colleagues and mentors, while at the same time teachers participated in learning communities that help to bridge the elementary-secondary instruction gap.

Introduction:

Thirty participating teachers from fifteen elementary and middle schools in Green Bay participated in a sequence of three graduate-level courses through St. Norbert College. The purpose of this sequence was to increase the teachers' grasp of math content, as well as heighten confidence in development of engaging instructional strategies and enhance the ability to apply mathematical concepts to science teaching.

Goals and Objectives:

The proposed project deepened mathematics content knowledge of participating teachers, including those at the intermediate level who are least likely to have a math-oriented academic background. Funding and implementation of this project increased the ability of participating teachers to understand and use effectively *Wisconsin's Model Academic Standards for Mathematics*. Teachers' classroom instructional techniques were video recorded for self-analysis and guided reflection with colleagues and mentors.

Program Plan:

During two weeks in June 2007, the thirty participating elementary and middle school math teachers attended a math content course at St. Norbert College in DePere. Following the last day of the class, the MAP test was again given to all grant teachers. Mr. Miller again looked at the increase in MAP RIT scores and also individual strand scores stating: "a second run of the bivariate correlations using spring and summer RIT scores for the pilot group reveals a statistical correlation in the areas of overall RIT, Algebraic Concepts, Geometry, and Statistics." This indicates that our initial goal of increasing mathematics content knowledge has been reached.

The summer 3-credit workshop addressed *Wisconsin's Model Academic Standards for Mathematics*. Although the summer workshop was on mathematics content, conceptual understanding and procedural fluency were stressed as well. Knowledge of facts is important; however, knowledge of procedures – how and when to use them, the right time and the skill required to perform them correctly and efficiently are all critical to truly understanding math content.

The one-credit yearlong course covered mathematical pedagogy; three part-time facilitators in Green Bay made follow-up classroom visits to each teacher. These facilitators made observations and helped coach each teacher during the 2007-2008 school year.

During the summer of 2008, the teachers attended a two-credit course through St. Norbert College on Math/Science Applications. Fieldwork was an integral part of this course and teachers learned and shared successful mathematics instructional strategies by focusing on best teaching practices.

Evaluation and Reflection:

The final report by the grant evaluator, Marge Wilsman, has not yet been finalized so is not included in this section of the Program Summary. Participating teachers and a control group of teachers completed a MAP Mathematics Test both before and after participating in content knowledge training. The mean RIT score before the content knowledge training was 259.23. After the intervention, the average was 265.90. In addition to the overall gains, the following gains were also noted:

- Computation, 3.92
- Geometry, 6.88
- Measurement, 1.20
- Statistics, 16.47
- Algebraic Concepts, 10.73
- Problem Solving, 6.20

The following changes to the median for overall MAP RIT score and in the sub-goal areas occurred:

- Overall MAP RIT, + 5.5
- Computation, + 4
- Geometry, + 5
- Measurement, +5.25
- Statistics, +11.75
- Algebraic Concepts, +9.5
- Problem Solving, + 4.5

We compared, not only their growth in content but their attitudes to that of a control group of teachers. In comparing the median growth using the NWEA MAP test, the grant teachers surpassed their counterparts in the areas of Measurement, Geometry, Statistics, and Algebraic Relationships as well as overall RIT score. The grant teachers also far surpassed the control group in pedagogical growth; for example, areas dealing with allowing 'wait time' for students, allowing students to explain their solutions to one another, focusing on sense making and understanding of the math they are learning, and allowing/showing multiple representations for the same problem/solution.

Literature Review:

The project activities proposed by the partnership submitting this application are designed on a foundation built around a review of scientifically-based research. The paragraphs that follow discuss and cite the current state of scholarly knowledge that supports this project. Through this brief review of professional academic literature, a clear indication of the rationale for selecting and designing the proposed activities may be discerned. This section also explains how the proposed activities may be reliably forecast to improve student academic achievement while strengthening the quality of mathematics instruction in the middle grades of GBAPS.

The *National Council of Teachers of Mathematics* (1989, 2000) calls for reforms in mathematics instruction to move children beyond attainment of mathematical knowledge to the understanding of mathematical concepts, and the ability to apply their knowledge and understanding to relevant and meaningful problems. The Council recommends changes in instructional practices that transform classrooms from being teacher-centered to student-centered learning communities. Effective implementation of this change, however, requires professional development for teachers – not only in alternative instructional practices, but also in the understanding of mathematical content and alternative assessment strategies.

Recent research is clear in pointing toward fourth grade as the most appropriate age level for "early exposure to problem-solving perspectives (Moseley, *Students' Early Mathematical Representation Knowledge*, 2005), as proposed for the content skill-building graduate course during summer 2007. Teachers' observation of student activity, followed by reflection upon the pupils' ways of dealing with mathematical problems, both play important roles in the instructors' own processes of learning from interacting with their students (Margolinas, Coulange, and Bessot, *What Can the Teacher Learn in the Classroom*?, 2005) – a component of the proposed guided self-analysis and reflection to be conducted by the project facilitator among participating teachers. Targeting for this program elementary teachers who are generalists and middle school teachers who neither majored nor minored in mathematics is encouraged by the conclusion of Alvaro Galvis' research (*Seeing Math Research: Promising Gains*, 2006) that students who have the most difficulty with math change the most when teachers' knowledge of pedagogy and content is improved.

With respect to on-site professional development, review of research by the National Council on Staff Development documents that staff development experiences are more effective when they are job-embedded, results-driven, and standards-based – as proposed in this partnership application. In its *Journal of Staff Development,* the Council concludes that effective professional development must incorporate opportunities for teachers to analyze student work together and design new ways of teaching, experiment with new strategies, and reflect on the results. These kinds of job-embedded activities are most effective when they also include participating in a teacher network, observing model teachers, mentoring, and planning with colleagues (*Grounded in Research*, JSD, summer 2001, page 32).

Madison: Science Masters Institute

Est. 2006

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Partners:

- Beloit School District
- Deerfield Community School District
- Madison Metropolitan School District
- Monona Grove School District
- Mount Horeb Area School District
- Oregon School District
- Sauk Prairie School District
- Sun Prairie School District
- Wisconsin Heights School District
- SCALE (an NSF Math/Science Partnership)
- University of Wisconsin-Madison

Abstract:

Through the Science Masters Institute (SMI), the Madison Metropolitan School District (MMSD) and the school districts of Beloit, Deerfield, Kettle Moraine, Monona Grove, Mount Horeb, Oregon, Sauk Prairie, Sun Prairie, Wisconsin Heights, and the University of Wisconsin-Madison joined forces to raise middle school students' science achievement via an ongoing, intensive program of content-based teacher professional development. Middle school science teachers from the partner school districts were brought together in nine courses co-designed and co-facilitated by UW STEM faculty members and an MMSD secondary science resource teacher. In addition to content knowledge, teachers engaged in their own learning using content-specific pedagogical instruction and modeling that will in turn support them to create their own standards-based, inquiry classrooms to effectively engage middle school students in developing understanding of fundamental science concepts.

Introduction:

Not since the Sputnik-related science revolution of the 1960's has there been such strong concern that links our country's competitiveness in the world economy to the quality of science education. A recent National Academy of Sciences report urges the nation to "compete by optimizing its knowledge-based resources, particularly in science and technology." A telling example of the challenge facing our country was noted in the NCES/TIMSS global studies of science lessons, which found the level of conceptual challenge and the density of science content in American classrooms to be lower than in many other countries; e.g., knowledge about the nature of science and metacognitive strategies accounted for no more than 2% of lessons.

Issues regarding middle school science are common across our project's consortium and, indeed, nationwide. Though over 59% of MMSD teachers have a Master's degree or higher, a high percentage of middle school teachers are not certified, nor have advanced coursework, in the content area in which they teach. Only 12% of MMSD middle school science teachers are science certified, with the other 88% providing science instruction with only elementary or special education certification. In a memorable

response to a question asked of 6th grade teachers in advance of a professional development session, one MMSD teacher lamented, "How can I teach this to my students if I don't understand it?"

Even experienced science teachers face increasing content knowledge requirements. Wisconsin's grade level standards in science significantly impact the structure of middle school science programs. Teachers from the traditional program model (e.g., 6th grade focused on one science content area) were expected to teach to performance standards from all content areas including earth and space, life and environmental, and physical science at all grade levels. These teachers need a deep understanding across diverse content standards and need to engage students in learning science using an inquiry approach.

MMSD has experienced a rapid increase over the last 15 years in the number of students in poverty, students with limited English proficiency, students enrolled in special education courses, and students of color. As Table 1 below indicates, many of our other consortium districts now face larger diverse student populations as well. These demographic shifts require changes in instructional strategies and tools to address the range of learning needs presented by all of our students.

Table 1: Consortium Member Enrollment Statistics, 2005-06

	# of Middle Schools	# of Middle School Students	% Low Income	% Students of Color
Beloit	2	1,567	61%	48%
Deerfield	1	120	1%	1%
Kettle Moraine	1	1,015	6%	3%
Madison	11	5,146	41%	45%
Monona Grove	1	650	10%	10%
Mount Horeb	1	531	10%	3%
Oregon	1	550	10%	3%
Sauk Prairie	1	614	16%	9%
Sun Prairie	2	1,222	20%	19%
Wisconsin Heights	1	226	17%	8%

As seen in Table 2 below, 2005 WKCE scores show significant numbers of 8th graders scoring below "proficient" in science in our consortium's two largest districts (Beloit and Madison), with three of our smaller districts having at least 15% below "proficient" (Mount Horeb, Sun Prairie, Wisconsin Heights). Further, as is apparent in Table 3 below, each of the SMI partner districts is struggling with a significant achievement gap across all No Child Left Behind (NCLB) sub-groups. This gap is especially problematic, given the need for greater teacher content knowledge and a broader range of pedagogical skills that includes inquiry-based instruction and differentiation. With the imminent inclusion of science in measures of Adequate Yearly Progress under NCLB, all of our consortium districts are especially anxious to improve science teaching so all students can achieve proficiency.

Table 2: Eighth Grade WKCE Science Scores, November 2005

	% No WKCE	# Minimal	% Basic	% Proficient	% Advanced
Beloit	3%	14%	26%	42%	15%
Deerfield	0%	0%	6%	51%	43%
Kettle Moraine	1%	1%	7%	52%	40%
Madison	6%	8%	13%	38%	35%
Monona Grove	1%	4%	10%	38%	47%
Mount Horeb	0%	4%	11%	35%	49%
Oregon	2%	3%	7%	49%	39%
Sauk Prairie	9%	2%	7%	41%	50%
Sun Prairie	1%	5%	13%	53%	28%
Wisconsin Hts.	0%	4%	11%	44%	41%

Table 3: Percent of Students Scoring Minimal or Basic on the 8th Grade WKCE in Science, by Income and Minority Status

	Low Income	Not Low Income	Minority	White
Beloit	47%	28%	53%	31%
Deerfield	*	*	*	*
Kettle Moraine	18%	7%	11%	8%
Madison	40%	9%	37%	10%
Monona Grove	54%	11%	42%	12%
Mount Horeb	50%	12%	*	*
Oregon	50%	8%	27%	10%
Sauk Prairie	18%	7%	50%	6%
Sun Prairie	42%	13%	44%	13%
Wisconsin Heights	*	*	*	*

***Per DPI policy, these data are not reported to protect the privacy of students in groups that are small (5 or fewer); or, for larger groups, to avoid indirect disclosure of information about the smaller group.

The content area focal points of SMI, shown below in Table 4, emerged from analysis of recent surveys of MMSD teacher development needs and 2005 WKCE data. For example, SMI project leaders examined the degree of correlation between teacher responses to the 2005 MMSD science survey (related to the areas of content support needed to teach science inquiry) and item analysis summaries from the 2005 WKCE. They also reviewed the results of two spring 2006 surveys of MMSD middle school science teachers that identified the degree of difficulty their students have with specific content areas and gauged their interest in a possible SMI project.

Table 4: Greatest Content Area Needs of Middle School Science Teachers

Physical Science	Life & Environmental Science	Earth & Space Science
Motion & Forces	Cellular Structure & Function	Earth's History
Properties & Changes in Matter	Natural Selection & Evolution	Earth in the Solar System
Transfer of Energy	System Interaction & Regulation	Structure of Earth's Systems

Since our professional development consortium was already in place through the Title IIB funded Math Masters project, our project director consulted with key leaders from each partner organization to

adapt the successful Math Masters design to meet the needs described above. In so doing, the partners reviewed the alignments of student achievement and teacher knowledge data and the following research and empirical experience as a consortium: 1) the lessons learned from their prior successful professional development efforts, 2) research on the characteristics of effective professional development and on the impact of misconceptions on effective science teaching and learning, and 3) recommendations of the National Research Council on strategies for improving science education.

Goals and Objectives:

The goal of Science Masters Institute (SMI) is to increase middle school students' achievement in science by strengthening the quality of science instruction by providing content and inquiry-based professional development linked to *Wisconsin's Model Academic Standards for Science*. In addition, high leverage research-based strategies would be incorporated to develop student understanding of fundamental science content.

SMI objectives address the following:

1. *Teacher Knowledge*: Increase the science content knowledge of middle school teachers in the partner school districts by offering high-quality content and inquiry-based courses taught by UW-Madison STEM faculty supported by a secondary science resource teacher.
2. *Improve Instruction*: Improve participating teachers' understanding of how students learn science content and ensure that the new content knowledge is incorporated into the classroom by offering pedagogical and instructional supports.
3. *Improve Curriculum Implementation*: Enhance implementation of standards-based science curricula within classrooms by expanding teacher knowledge of the essential content, concepts, topics, and instructional strategies most relevant to middle school science.
4. *Improve Student Achievement*: Raise middle school student achievement in science in all grades as teachers with deeper content knowledge, understanding of student learning, and mastery of the curriculum teach more students in more strands of the curriculum over time.
5. *Narrow the Achievement Gap*: Reduce the achievement gap in science among all NCLB sub-groups by helping teachers master key concepts they can use to adapt instructional goals, assessment strategies, and learning activities to meet the needs of all students.

Program Plan:

Science Masters Institute offered seven separate 20-hour (face-to-face) content courses throughout the 2007 calendar year for middle school teachers who support students learning in science from the school districts of Beloit, Deerfield, Kettle Moraine, Madison, Monona Grove, Mount Horeb, Oregon, Sauk Prairie, Sun Prairie, and Wisconsin Heights. Each course was designed with a focus on a fundamental area of science as identified in the Wisconsin Model Academic Standards (WMAS) and included: Motion and Forces, Properties and Changes in Matter, Transfer of Energy, Structures and Functions in Living Things, Earth in the Solar System, Earth's History, Heredity, Diversity and Adaptations of Organisms. A 10-hour online component focusing on pedagogy accompanied each 20-hour face-to-face content course. The topics for the online portion of each course were based upon how people learn, the use of science notebooks and the survey of enacted curriculum. The texts *How People Learn: Bridging Research and Practice and Science Notebooks: Writing About Inquiry* were used.

The seven content courses were offered in 2008 along with two additional courses that address the fundamental areas of science in the WMAS including Regulation & Behavior and Structure of Earth's Systems. All courses were co-designed and co-facilitated by a UW-Madison STEM faculty member and a Madison Metropolitan School District Secondary Science Resource Teacher.

The design of each SMI course was purposeful and provided teachers an opportunity to learn science by engaging in inquiry. Their prior knowledge was elicited and taken into account as new ideas were presented and considered. Teachers added to their existing conceptual framework as they were given opportunities to make sense of what they were learning. They were asked thoughtful questions and given time and space to reflect on how they were going about this type of learning. Teachers also created their own science notebook as part of each SMI course. They used this as they were metacognitive about their own learning process and to retrieve data that was important later. In considering the use of a science notebook, excerpts from actual scientists' (Jane Goodall, Linus Pauling, Charles Darwin, Francis Crick, Thomas Edison, etc.) notebooks were examined and discussed. In addition, time was devoted to discussing use of science notebooks with middle school students. Teachers are being asked to teach science using an inquiry approach when very few of them have ever learned, taught, or observed someone teach in such a way. This learning experience has proven powerful for teachers, especially those who have completed more than one SMI course. Teachers are encouraged to take the three SMI courses that align with the science content they teach their middle school students.

Evaluation and Reflection:

The WCER component of the evaluation has two key parts: (1) content, quality, and immediate impact of the institute, and (2) effects of institute training on classroom instruction. During 2007, 47 teachers participated in seven SMI courses offered. Based upon anecdotal feedback from participants, teachers found the program to be valuable and relevant to the needs of their classroom instruction. Teachers felt challenged by the content of the courses, in a safe environment that allowed them to comfortably ask questions to expand their content knowledge. Over half of the 2007 teacher participants chose to participate in more than one of the SMI courses, demonstrating the positive response teachers had towards the program.

Evaluation of the content, quality, and immediate impact of the SMI utilizes three instruments:

a. *Pre and post-test of teacher participants of the SMI*. The evaluation of the effects of the SMI on teacher content knowledge requires participants of each institute course to complete a 15 to 20 item multiple choice pre- and post-test to compare content knowledge prior to participation in the course and at the end of the course. The test items are drawn from a pool of public-released test items. From an overall analysis of the 2007 pre and post-test results, the teacher participants gained in knowledge of each of the seven course content areas.

b. *SEC of the institute content and cognitive demand*. At the end of each institute course, the co-facilitator of each institute retrospectively completes the Survey of Enacted Curriculum (SEC) of the content covered at that institute. The use of the SEC in this manner serves as documentation of opportunity to learn (OTL) of the institute and as a template for change in teacher instruction on the SEC completed by the teacher participants.

c. *Survey of intended and actual instructional change*. Teacher participants of each institute course complete a summary narrative at the end of each institute course explaining what changes in instruction they foresee as a result of the institute training, if any. As validation, a similar question was asked of each participant after they have taught the topic covered at the institute. Responses to the question were coded according to the type of planned and actual changes. Analysis focused on the relationship between the changes and the content covered.

Effects on Classroom Instruction:

The effects of the SMI on classroom instruction were measured by a pre- and post-SEC completed by the teacher participants. The SEC was administered to teachers during each SMI course and then again after the teachers have taught the science content presented at the institute. Teachers' pre- and post-test results were compared to pre- and post-SEC responses and pre- and post- intended and actual changes in instruction. After reviewing the initial evaluation results, the following seven hypotheses were developed regarding the potential effects of the SMI professional development on classroom instruction:

- Measures of the effectiveness of professional development went up in the year after the teacher participated in the SMI course (because the course is a substantial part of the professional development in that year).
- Alignment of instruction with the content of the SMI courses was greater in the post data than the pre data (e.g., more time on the topic covered and/or greater depth).
- Alignment of instruction with the Wisconsin standards and/or MMSD scope and sequence was greater in the post data than the pre data (because the SMI courses were constructed according to the standards).
- Participation in the SMI courses resulted in increased use of science notebooks and increased cognitive depth.
- Depth/breadth comparison showed more depth and breadth (more topics) in the post data.
- All of the above relationships were stronger the greater number of SMI courses the participants enrolled in.
- Increases in cognitive demand was reflected (and correlated with) increases in independent measures of the student activities that teachers use to raise cognitive demand.

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Pecatonica: Mathematics Achievement Project
Est. 2006

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- Mineral Point Unified Schools
- North Crawford Schools
- Onalaska School District
- Pecatonica Area Schools
- Platteville School District
- Prairie du Chien Area Schools
- Riverdale School District
- University of Wisconsin-Platteville

Abstract:

The vision of the Mathematics Achievement Project (MAP) is to ensure that more highly qualified mathematics teachers were part of the educational infrastructure in western Wisconsin resulting in increased student learning and performance. To achieve this vision, the University of Wisconsin–Platteville, CESA 3, CESA 4, and 21 LEAs (of which four are considered high need in mathematics) formed the Western Wisconsin Mathematics Improvement Consortium (WWMIC). The partnership was formed on the premise that student achievement could be improved only by enhancing the content knowledge and the quality of instruction by mathematics educators.

The WWMIC originally received $260,000 for two years to support 25 teachers. Due to high interest, we petitioned the Department of Public Instruction to include an additional 25 teachers for a total of 50 participants (an addendum of $52,750). Dollars were expended in grant coordination (webmaster, clerical, and coordinator salaries, preparation materials ($41,000), instructional salaries ($16,000), participant stipends and resource allocations ($55,000), to support professional development of the expert panel ($20,000), evalaution materials which included the SEC and 4Sight Math Benchmark Assessment ($9,500), the hiring of an external evaluator ($16,000), and other miscellenous expenses encumbered during the summer training such as food, travel, and lodging ($11,000).

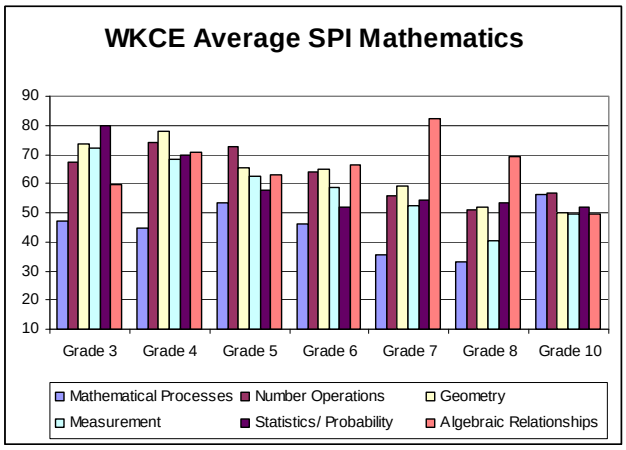
The summer institute structure for year one is designed to address the state standards for mathematics as well as interpreting data and following a constructivist pedogogy and cooperative learning. The math activities align with Marilyn Burn About Teaching Mathematics Part I trainings (ATM-1). The philosophy of the training helps teachers understand mathematics curricula and what is needed to teach math effectively. Teachers learned how to develop students' abilitites to think and reason; build students'

number sense, and perform computation and problem-solving skills. In year two, the summer institute focused on About Teaching Mathematics – Part 2. After attending Part 1, teachers returned to examine their classroom implementation, refine their teaching practice, and learn more mathematics. Experiences from the second session went into greater depth and breadth on all of the state standards and linking assessments to instruction. Year three of the grant process was the most powerful. Returning participants went into even greater detail on best practices for mathematics instruction and now begin to share their knowledge with other teachers at their school. This built capacity by perpetuating effective instruction and sustaining mathematics professional development at the local level. The long-term impact of this project is that more highly qualified mathematics teachers become part of the educational infrastructure in western Wisconsin, resulting in increased student learning and performance.

Introduction:

The primary intent of NCLB is to provide all children with a fair, equal, and significant opportunity to obtain a high-quality education delivered by highly qualified teachers. Mathematics is subject to mandatory testing with schools being rewarded or sanctioned according to the provisions of NCLB. Numerous studies consistently have shown that American students perform at substandard levels when compared with students from other industrialized countries and that fewer U.S. students are choosing a mathematics-related career. According to 2003 *Trends in International Mathematics and Science Study* (TIMSS) data, no measurable changes were detected in the average mathematics scores of U.S. fourth graders between 1995 and 2003. Moreover, the available data suggest that the performance of U.S. fourth graders in mathematics was lower in 2003 than in 1995 relative to the 14 other countries that participated in the studies. Although similar TIMSS data does indicate some improvement for eighth graders, this group was still outperformed by students in five Asian countries and four European countries. Additional data suggest that the U.S. is doing a poor job of recruiting young people to compete for 21st century jobs that require a mathematics and science background. According to Dr. Willard Daggett, President of the International Center for Education, nearly one-half of all U.S. university enrollments in science, technology, engineering, and mathematics are students who are non-U.S. citizens. In 2004, only 5 percent of the bachelor's degrees earned in the United States were in science and engineering as compared to 60 percent of the degrees earned in China. Since 1975, the U.S. has dropped its ranking for degrees received in science, mathematics, and engineering from 3rd to 17th in the world. This decline in U.S. enrollment in science, mathematics, and engineering careers, coupled with marginal achievement results, at best, will result in severe human and economic consequences for our country if not reversed in the future.

Table 1



In Wisconsin, WKCE-CRT test results parallel the national trends. With a few exceptions in individual standards or at specific grade levels, overall math scores decline from grade 3 through 10 (*see Table 1*). Additional analysis of Standards Performance Index (SPI) data indicates the lowest score among the six tested content standards is in the area of mathematical processes.

In summary, national and state level data reveal declining math scores, questions about math pedagogy, and fewer students selecting a mathematics-related career. To assess the needs in western Wisconsin, the WWMIC designed and administered an electronic survey instrument to math teachers at all grade levels in June 2006 *(See Appendix C).* The survey examined teacher qualifications, pedagogical practices, teacher confidence in teaching the math standards, and identification of math content areas in which their students struggle.

Sixty-nine K-10 mathematics teachers responded to the electronic survey requesting information regarding their professional development needs. Resulting data revealed that 56% of the teachers had sixteen years or more of classroom experience, with 48% having attained a master's degree or more. However, 67% of the respondents have three or fewer post-graduate credits in math. Most telling is that 59% have not received professional development in math within the last two years.

Survey respondents were asked to reply to the following question, "What areas of math do your students struggle with the most?" Their responses are summarized in Table 2 below.

Table 2: Content Areas in Which Math Students Struggle

Grade Level	Area of Students' Difficulty
Primary	Math facts; word problems; money
Elementary	Math facts; fractions; word problems; division; algebra; stats and probability
Middle School	Fractions; word problems; writing math processes; probability
High School	Fractions; word problems; 2D and 3D geometry; algebra

At the second WWMIC planning session, other needs also were identified by teacher and administrative participants. Typical teacher and administrative comments included:

- "Math instruction today should not only teach students to get the correct answer but also teach them the mathematical processes required to obtain the correct answer."
- "There needs to be a balance between using the new math techniques that emphasize understanding and explanation and the traditional math that teaches basic facts and computation."
- "Teachers must have an array of teaching strategies for meeting the unique needs of diverse learners (i.e., differentiated instruction)."
- "In addition to practice and concept application, student seat work must also include invent/think activities."

Research findings, test results, and needs assessment survey data, confirm the need for improved student achievement and enhanced teacher quality. To address these needs, the MAP proposal provided professional development focusing on increased mathematics content knowledge and improved instructional practices. The MAP proposal also encourages participation by districts that have been historically under-represented or under-served. Typically, many school districts in western Wisconsin represent small, rural communities with few resources and high percentages of students who qualify for free or reduced lunch.

In CESA 3, there are 11 districts that are identified as high need districts in mathematics, and in CESA 4 there are 8 districts that meet the high need criteria. These 19 high need school districts represent 28 percent of the eligible LEAs in the state. These districts were given priority in participation in all proposal activities. Table 3 summarizes the ten national, state, and local needs identified by the WWMIC planning committee for this proposal.

Table 3: Summary of WWMIC Needs

Identified Need	Description
Student Achievement	Increase student achievement in math
Professional Development	Provide high quality, rigorous, on-going, and sustained professional development.
Mathematics Content	Update teacher content knowledge in mathematics.
WMAS Knowledge	Enhance teacher knowledge of the WMAS.
Aligned Curriculum	Align math curriculum with WMAS.
Constructivist Pedagogy	Implement inquiry-based, constructivist pedagogy.
Differentiated Instruction	Provide training to meet diverse learner needs.
Balanced Assessment	Employ balanced assessment strategies that include explanations of how you got the right answer.
Teacher Incentives	Offer stipends and credit opportunities to encourage teacher participation.
Resource Allocation	Provide resources and equipment.

Goals and Objectives:

Based on ten national, state, and local needs that were determined by the WWMIC, six project goals were identified:

1. Expert panel: An expert panel including math and engineering professors from University of Wisconsin-Platteville (UWP), three math teachers, and two CESA employees have dissemenitated information to participants on the goals outlined in this grant.
2. Curriculum alignment: Summer institute discussed interpretation on the WI Frameworks and their alignment to curriculum.
3. Mathematics content: Teachers participated in hands-on activitities to increase their math content knowledge and new way to teach math.
4. Constructivist pedagogy: Marilyn Burns constructivist math approach was used by the expert panel, and teachers completed two lesson plans per year as documentation on how they are implementing constructivist math lessons in their own rooms.
5. Learning plans: Two math lessons on two different math standards were submitted each year. One coopertive learning plan was also submitted.
6. Student achievement: Data mini-retreats were conducted to assist teachers in creating an assessment literacy to inform their instruction and thus, impact student achievement.

The target audience invited to participate were K-12 teachers in the CESA 3 and CESA 4 region. The majority of the teachers came from CESA 3 since they have more high need LEAs and the summer institute was also held in the CESA 3 region.

Program Plan:

Thirty-five teachers participated in the first summer institute. The format of most of the days began with whole group instruction on a math standard and a hands-on, group problem solving activity. The afternoon sessions were grade level break-out sessions (K-2, 3-5, 6-8, and 9-12) that reinforced and represented how to instruct that particular standard in the grade level they taught. Teachers also were able to do several make and take projects in the afternoon sessions. Each teacher also received $600 in materials to support the new learning activities and strategies presented at the summer institute.

Teachers completed reflection logs daily. They assembled three-ring binders of information. The participants were each offered a stipend of $500 to participate. The UWP campus was able to extend credit options outside of the grant to exchange the $500 for five credits. Most all of the participants took advantage of this opportunity.

Two networking nights follow the summer institute. Networking nights happened in December and in April. Lesson plans were shared and updates from the Expert Panel were disseminated.

Evaluation and Reflection:

A quasi-experimental research design was used to collect qualitative and quantitative data concerning both teacher performance and student achievement. Data from pre- and post-content tests, an inquiry based self-assessment, journaling, and assessment rubrics for the learning plans was used to provide teacher feedback. The Surveys of Enacted Curriculum (SEC) provided valid and reliable data on the alignment between state standards and what is actually being taught. To measure student achievement, we

chose nonequivalent control group design in which pre-test and post-test were administerd after an experiemental treatment (i.e, two weeks of summer instruction). Student achievement gains were measured against established baselines using WKCE-CRT proficiency scores and Standard Performance Indicators (SPI) data along with the 4Sight Benchmark Math Assessment (developed by the Success For All Foundation, Inc.) which are administered each fall and spring. The WWMIC expectation is that comparison data demonstrated that engaging in scientifically-based professional development enhances student academic performance in mathematics.

Literature Review:

The question must be asked, "Why do U.S. students fail to keep up with their peers in other countries in mathematics?" According to Marilyn Burns, "Teachers can't teach what they don't understand, and they can't teach well what they don't love." Numerous studies have shown that one of the primary reasons for poor student performance and lack of student interest in mathematics is that teachers are not adequately prepared to teach mathematics content.

What does it take for students to become more mathematically literate? The WWMIC believes that math literacy can be improved **only** by enhancing the content knowledge and the quality of instruction by mathematic educators. "To prepare mathematically literate citizens for the twenty-first century, classrooms need to be restructured so that mathematics can be learned with understanding" (Carpenter, *Teaching and Learning Mathematics with Understanding*, 2001).

Research from the National Council of Teachers of Mathematics (NCTM) states that "effective teaching requires knowing and understanding mathematics, students as learners, and pedagogical strategies." Specifically, the NCTM states that effective teachers "must know and understand deeply the mathematics they are teaching" (*Principles and Standards for School Mathematics*, 2000). Teachers need to "understand the big ideas of mathematics and be able to represent mathematics as coherent and connected enterprise (Shifter, 1999).

In January of 2001, the National Research Council released a report on Pre-K-8 entitled: *Adding It Up: Helping Children Learn Mathematics*. The report calls for an overhaul of curriculum, instruction, and assessment in mathematics based around the five intertwined strands of mathematical proficiency. The integrated and balanced development of all five of the strands listed below should serve as a framework to reform the teaching of mathematics:

- Conceptual understanding: Comprehension of math concepts, operations, and relations.
- Procedural fluency: Skill in carrying out procedures flexibility, accurately, efficiently, and appropriately.
- Strategic competence: Ability to formulate, represent, and solve mathematical problems.
- Adaptive reasoning: Capacity for logical thought, reflection, explanation, and justification.
- Productive disposition: Habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy.

One of the premier programs in the country that addresses this reform framework is the *Math Solutions Professional Development Program* offered by Marilyn Burns Educational Associates. From their work with more than 100,000 teachers and administrators, they have learned that mathematics professional development must focus on three essential issues:

- Math content – helping teachers deepen their understanding of the math they have to teach;

- How children learn – giving teachers a model for helping children make sense of mathematics concepts and skills; and
- Effective teaching strategies – providing teachers classroom ideas and materials for delivering standards-based instruction.

This proposal called for an expert panel to be trained as mentors in the Math Solutions Program. Through this rich professional development opportunity, the expert panel will have a better understanding of math concepts, a broader array of effective teaching strategies, and a wider network of trained teachers for sharing best practices.

Rio: Mathematics Excellence in the Middle Grades
Est. 2006

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- Port Edwards School District
- Princeton School District
- Randolph School District
- Tri-County School District
- University of Wisconsin - Platteville

Abstract:

Mathematics Excellence in the Middle Grades (MEMG) is a three-year professional development project designed to raise student achievement by developing deeper mathematical content and pedagogical knowledge in teachers of students in grades 5-8. In partnership with the education and mathematics departments at UW-Platteville, eight days of professional development centered on *Wisconsin's Model Academic Standards for Mathematics* was scheduled during each of the summers from 2007-09. On-site coaching and assistance to all consortium schools was available in years two and three of the grant to extend the summer learning, and further develop a sustainable model for improving mathematics instruction and promoting reflective best practice. A wiki website connects participants to resources and to one another to provide an electronic learning community.

Introduction:

Twelve rural Central-Wisconsin districts, serving nearly 5,000 middle school students, joined together to develop the MEMG project. While the school districts of Rio, Princeton, and Pittsville are officially designated as "High Need" eligible for this program, other schools in the partnership are also challenged by high poverty and low levels of student achievement in mathematics. In some grades, as few as 52-56% of the students scored in the advanced and proficient ranges on the 2005-06 WKCE-CRT Mathematics, and in three districts 40-49% of students come from families who qualify for free or reduced lunch. The second year was additionally challenging as the paper industry, long a centerpiece of the local economy, experiences additional closings and buy-outs, and the jobs of parents are not replaced. Some districts in the consortium also struggle with issues of disproportionality relating to student achievement for students with disabilities.

In small districts where one or two individuals may provide all the math instruction for a grade level, teachers indicate a need for professional development focused on developing in-depth knowledge of state mathematics content standards, as well as improved instructional and assessment strategies to address

diverse learners. The growing emphasis on Response to Intervention and Progress Monitoring underscores the need to use assessment in formative and flexible ways to meet student needs.

Strengthening and developing parent partnerships is also a high priority for MEMG. Every parent plays an important role in encouraging and supporting student achievement in math, but the grant's role takes on special importance in districts where reform curricula are being implemented. Without support from teachers and administrators in such districts, parents are left not knowing how to help students with this "new math" and its focus on alternate algorithms, reasoning, and problem solving. Written into the grant are parent outreach activities that contribute to building a multi-generational community of learning.

In response to these identified needs, MEMG outlines a high quality, sustainable professional development program closely linked to the Wisconsin Educator and Model Academic Mathematics Standards. The plan reflects research-based best practice in mathematics and professional development.

Program Plan:

The first professional development activity available to math partner teachers was the Wisconsin Math Council Green Lake Math Conference in May 2007. Eighteen teachers from nine districts in the consortium attended the two-day conference, choosing sessions to meet their needs each day and networking during their overnight stay.

The mathematics content for the first year summer institutes in July and August 2007 centered on the Algebra and Data, Probability, and Statistics strands. Pedagogical content knowledge, a more subtle underlying understanding of the interrelationships among mathematical ideas, and the ability to foster student thinking and address misconceptions, was addressed through a combination of carefully selected hands-on instructional experiences and a focus on differentiated instruction in mathematics. Instructors modeled this kind of discourse through the institute's design and by engaging reluctant and eager students in worthwhile mathematical tasks in the two targeted strands.

Of the thirty teachers who attended one or both of the summer institutes, twenty-three teachers chose to continue their professional development by drafting action research plans for the 2006-07 school year. These credit-bearing projects have topics ranging from the implementation of a commercial program as a component of the district's response to intervention and progress monitoring, to innovative cross-discipline hands-on math sessions developed to address student misconceptions as reflected in WKCE-CRT scores. Other projects focused on differentiated instruction, open response questioning, and developing a classroom milieu that supports productive group work. The impact of the summer institutes on one of our math grant partner teachers had a beyond-the-classroom impact through her action research project to develop and present a math resource book with instructional activities to support Wisconsin's Extended Grade Band Standards for students with significant disabilities.

The program plan for the remaining years of the grant will follow a similar pattern. The winter partnership meeting focused on action research updates from participants and activities surrounding Family Math Fairs to be scheduled in schools sometime this spring. Recruiting has begun to expand our capacity for the two-week summer institute which addresses the strands of Measurement and Geometry, and coaching continues onsite in classrooms and schools.

An additional resource for teaching and learning provided to partner-teachers is the wiki space created to bring together websites and technology applications applicable to the strand focuses. The space at http://cesa5mathscience.wikispaces.com/ also provides links to common math text series, additional professional development activities and other topics of interest, and offers continued support, networking, and additional information on summer institutes, statewide math and leadership team meetings.

The overall goal of MEMG is to improve the academic achievement of students in mathematics across grades 5-8 by improving the mathematic content knowledge and teaching skills of their teachers. Teachers included in the first year of the grant included several Title 1 teachers and two special educators, in addition to teachers who teach all subjects including math, and junior high and middle school math teachers from public and one private parochial school in our area.

Evaluation and Reflection:

This study randomly assigns individuals to a control group in order to accurately measure the effects of the project on the "intervention" group (or MEMG consortium). In so doing, we randomly selected a comparison group of students from districts outside of the consortium that is very closely matched with consortium students targeted for this project. In the context of education, the comparison group consisted of the same number of consortium students targeted for this project who are closely matched with the intervention group in characteristics such as: prior test scores and other measures of academic achievement; demographic characteristics; grade level during the time period; methods used to collect outcome data and teachers' level of education, background, and experience.

The evaluation utilized a "pre-test" and "post-test" approach in which student achievement data were collected at the start and at annual intervals of the project from both the control and intervention (or consortium) groups; then analyzed to determine effectiveness of the project on student learning in mathematics. Sources of achievement data in such an approach primarily included standardized assessments/tests, such as WKCE-CRT.

A content evaluation pre-test was taken by the participants to determine knowledge base at the beginning of the summer institute. Another post-test was taken to determine the knowledge and skills acquired at the institute

From the outset, teachers have been involved in goal setting for MEMG based on item analysis of WKCE-CRT strand data and a teacher needs analysis. The model for the program was developed out of these findings, and includes the two-pronged approach of improving both the mathematics content knowledge and pedagogical content knowledge (PCK) of middle school teachers.

Teachers participating in the first summer institutes reflected on MEMG's impact by observing that the most effective part of the program was "working together to complete tasks and discussing how to make changes at every level, and "the sharing and explanation of assessments." A recurring comment from participants was that the information about differentiation was the most valuable, along with sharing ideas for learning strategies. The idea of "strategies" encompasses an awareness of the diversity of student approaches to content, process, and conceptualization of mathematical ideas.

When asked how they thought their work would impact student learning, students commented that "thinking about how I present info as well as questioning and assessment" was key. Another teacher said, "I learned to foster student [learning through] hands-on activities and critical thinking skills." Pedagogical content knowledge was also reflected in such comments as [I now have] "great ideas and reasons to use them," and [the Institute has] "helped me to know how to approach teaching my students with different learning styles."

In addition to creating pre-tests for teachers that more closely mirror the essential content of the measurement and geometry strands and using the pre-test results to differentiate summer institute coursework to better meet our teachers' needs, participants in the second year of the grant also participated in the Surveys of Enacted Curriculum as part of the evaluation plan. Formative assessment continues to be an important link between instruction and student learning; analysis of student work is at the center of many of our participants' action research projects.

Literature Review:

The Wisconsin DPI Publication, *Planning Curriculum in Mathematics* (PCM), notes that learning mathematics with understanding is at the heart of improvement. We created our MSP grant with the same focus on authentic, inquiry-based, learner-centered curriculum that actively involves students in modeling, problem-solving, and conjecture. Putting teachers at the center in this rich environment, and structuring their conversation around higher order thinking and real-world connections, helps them develop the understanding that we wish to have them develop in their students.

Another guiding idea is that the learning needs of teachers should be at the center of effective professional development. In *Ideas That Work: Mathematics Professional Development*, researchers from the Eisenhower National Clearinghouse (ENC) for Mathematics and Science Education advocate a number of research-based strategies including partnering with institutions of higher education, developing professional networks, integrated and ongoing professional development, action research, study groups, mentoring, and coaching. Each of these strategies, save the study groups, has been successfully woven into the MEMG project. Additionally, immersion into problem solving and the use of technology for professional development, also noted as research-based strategies in the Ideas that Work publication, have been key elements in summer institutes as well as ongoing partnership meetings. This framework is further guided by the National Research Council publication: *How People Learn: Brain, Mind, Experience and School* which outlines four related attributes of optimal learning environments. Such learning environments, whether for students or teachers, are learner, knowledge, assessment, and community centered.

One additional resource that informs our work with teacher-partners is the innovative (if ten year old) Toolkit98 from NWREL http://www.nwrel.org/assessment/toolkit98.php, a publication designed to assist classroom teachers to become better assessors of student learning. These hands-on and guided reflection activities are designed to be used by those who coordinate and facilitate professional development in assessment for teachers.

Chetek: Math & Science Partnership Grant
Est. 2007

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- Grantsburg School District
- Luck School District
- Menomonie School District
- Osceola
- Pepin
- Saint Croix Falls
- Shell Lake
- Somerset
- Unity
- University of Wisconsin – Stout

Abstract:

The Creating Mathematics Excellence (CME) partnership between CESA 11, the University of Wisconsin–Stout and a total of 15 rural and high poverty school districts in northwestern Wisconsin – including Barron, Birchwood, Chetek, Clayton, Clear Lake, Grantsburg, Luck, Menomonie, Osceola, Pepin, Saint Croix Falls, Shell Lake, Somerset, Spooner, and Unity – have joined forces to develop this project. In creating this partnership, all of the identified school districts except Saint Croix Falls are included as eligible districts on the WDPI's High Need List for this grant opportunity. In fact, the poverty data secured from the free and reduced lunch rates in these districts reaches as high as 44%. This project served the needs of more than 5000 students. It also included upwards of 65 educators who teach in mathematics and special education programs across grades 3-9. In identifying the need for this project, we looked at the low student achievement and the need for more effective teaching in mathematics. The data available speaks to an overwhelming need for this project. The percentage of students in our districts who achieve proficiency on the WKCE-CRT for math reaches a low of 57% across the consortium in our ALL student data. More importantly, our students with disabilities scored as low as 0% proficient and as few as 33% with the economically disadvantages group. Teachers have indicated through our needs assessment a strong need for professional development focused on providing more in-depth knowledge of the WMAS for Mathematics, as well as instructional and assessment strategies to address the needs of our highly diverse students.

We have designed a comprehensive and focused project to support the identified needs within our consortium. Our partnership utilized scientifically based research and effective practices in mathematics and professional development. These activities are in line with the stated purpose of the Math and Science partnerships, Title II, Part B as well as the PI 34 and NSDC standards. The CME project is predicated on research findings that indicate that experienced teachers who know both their content and effective instructional strategies tend to produce higher achievement outcomes among their students.

To achieve this vision, our three year plan included a well developed set of activities: 1) a "Math Visions" Conference to provide an overview of the project components and activities, review the requirements of the project and professional development planning structures, communicate and provide input into the summer institutes, and introduce pre-post assessment tools for participants and students; 2) a two-week Summer Academy which focused on providing teachers with content expertise, pedagogical content knowledge, and instruction and assessment strategies related to the WMA standards in math; 3) a year-long follow-up assistance model with training modules and individualized feedback; and 4) A "Math Visions" Celebration Conference to summarize data and identify the components of a sustainable follow-up for the consortium. Each of these components was evaluated for structure, content, perceptions, and participant learning opportunities.

The anticipated effect of the project were to: improve the academic achievement of students in mathematics across grades 3-9, to enhance the mathematics content knowledge and teaching expertise and skill sets of classroom teachers in grades 3-9, improve the perceived attitudes of participating students, and to increase the number of teachers participating in our content-specific mathematics opportunities.

Introduction:

The data identified to support the needs for this project are extremely critical. Results from the 2004-05 (4, 8 and 10th grades) and 2005-06, and 2006-07 (3-8 and 10th grades) give us the basis for trends with our students' achievement. These trends indicate that an alarming percentage of students across our consortium are failing to grasp the content and skill sets identified with *Wisconsin's Model Academic Standards (WMAS) for Mathematics*. Our trend data shows the percentage of students in our districts who achieve proficiency on the WKCE-CRT for math reaches a low of 57% across the consortium in our ALL student data. More importantly, our students with disabilities or living in poverty have significantly lower achievement levels than their peers. As few as 0% of students with disabilities scored at the proficient or advanced level on the 2006-07 WKCE-CRT and as few as 33% within the economically disadvantaged group.

The teachers within our consortium identified the following as primary need for professional development:

- Standards need to be clearly articulated within and across the grade levels.
- Indicators need to be developed to assess how well our disaggregated groups of students are being provided for.
- Examination of disaggregated student achievement data needs to be clarified.
- Assessments need to be identified to provide screeners for student achievement and accommodation when necessary.
- Multiple methods of instruction and assessment need to be clarified to assess the depth of student understanding in content.

Furthermore, we conducted a Mathematics Study Group as a result of this survey. Our study group used the resource authored by Nancy Love: *Using Data/Getting Results: A Practical Guide for School Improvement in Mathematics and Science*. Our study group met weekly for a semester of collaboration and instructional support. The above mentioned needs were addressed and clarified. At the culmination of the study group, it was decided that these concerns would need further study and planning in order to adequately support teachers in their professional development. The needs assessment process also found that our districts are not utilizing the more challenging, standards-based curricular resources developed to

address the National Council of Teachers of Mathematics Standards, and subsequently funded by the National Science Foundation, such as Everyday Mathematics or Connected Math Project. Clearly, many of our students are being taught using outdated resources with little connection to the challenging curriculum outlined in our Wisconsin Assessment Framework in Mathematics.

Results from the assessment process clearly point to the need to improve both teacher and student mathematics proficiency. In evaluating the needs addressed by our survey participants, our project focused on these priorities:

- Increasing teachers' knowledge of content and skill development with the Wisconsin Model Academic Standards and Assessment Framework;
- Improving instructional strategies and assessment skills related to the standards; and
- Identifying and designing Tier II assessments to screen students who need more focused interventions.

The above mentioned priorities are by no means the only critical needs, but at this point must be addressed first. With the implementation of these essential needs we continued to address the others in the future either with this grant or regionally. The CME consortium feels strongly about a continued partnership.

Goals and Objectives:

Our CME consortium has designed the following goals and objectives to support the partnerships within our program.

Goal 1: *To improve the academic achievement of students in mathematics grades 3-9.*

- **Objective 1-1:** Using our baseline data, the percentage of students who score at or above the proficient level on the WKCE in mathematics will increase by at least 5% on the 2008-09 WKCE-CRT and at least 3% on the 2009-10 WKCE-CRT as compared to our baseline.
- **Objective 1-2:** Using our baseline data, the percentage of students in grades 3-9 who score at grade level or above, and meet grade level benchmarks as correlated to the Wisconsin Assessment Framework in Mathematics and the WMA Standards for Mathematics will increase on average by at least 5% by May 2009 and by 3% by May 2010 compared to our baseline.
- **Objective 1-3:** Students' perceived attitudes toward mathematics will improve as measured by a pre-test post-test NSDC design tool.

Goal 2: *To improve the mathematics content knowledge and teaching skills in classroom educators grades 3-9.*

- **Objective 2-1:** To increase the number of teachers, both regular and EEN staff, participating in content-based professional development. The number of teaching participants will increase by 5% over the length of the grant. At least 95% of targeted teachers will participate in all components CME activities.
- **Objective 2-2:** Teachers participating in the Math Standards-Based professional development activities will increase their mathematics content knowledge by at least 10 points as measured by

pre- and post-specific course tests and/or an instructor identified standardized math content assessment.

- **Objective 2-3:** Teachers will gain great insight into research-based pedagogical techniques to improve their ability to engage students as measured by instructor identified assessments.
- **Objective 2-4:** Develop a professional learning community within CME for math and special education teaching professionals that will define the criteria for group collaboration and research-based activities to support the professional development for the sustainability of the CME consortium project.

Program Plan:

Our partnership exists to provide professional development to 15 school districts and approximately 65 teachers (4 teachers from each district, both regular and special education). This professional development was based on the knowledge that the ability to teach is a career-long learning process and requires opportunities to develop current knowledge, skills and research-based pedagogical techniques and strategies. Our project entails implementing a high quality and sustainable professional development program that is closely linked to the WMA Standards for Mathematics and the PI-34 Wisconsin Teacher Standards (WTS).

Our model consisted of four components and was evaluated for structure, content, perceptions, and participant learning opportunities: a "Math Visions" Conference, a two-week Summer Academy, year-long Follow-up Assistance and Training Modules, and a "Math Visions" Celebration Conference. The project supported each teachers with two graduate credits (per week) – four graduate credits each summer with year-long follow-up, for each summer of participation through the University of Wisconsin – Stout. This credit option was supported throughout the school year by a required "lesson-study" component and a reflection process using the Wisconsin Teacher Standards as the content, skill, and disposition lens for professional development.

Evaluation and Reflection:

CME has implemented an evaluation plan that incorporates a well-designed experiment to provide rigorous evidence of effectiveness and to insure validity and reliability of the program outcomes. This project is based on a quasi-experimental design. The control group study compared outcomes (specifically student achievement) for an experimental group of students learning in demographically comparable districts outside of our consortium. These individuals were randomly assigned to comparison groups in order to accurately measure the effects of the project on the experimental groups (CME consortium). In the context of education, the control group consisted of students targeted for this project who are closely matched with the intervention group in characteristics such as: prior test scores and other measures of academic achievement (using the same measure that our study used to evaluate outcomes); demographic characteristics (poverty, disability, and/or gender); grade level during the time period of the project; methods used to collect outcome data (same test of mathematics skills administered in the same fashion to both groups, such as WKCE-CRT) and teachers of the same background, experience, grade level positions, and level of education (as per Evaluation of MSP Programs).

Our comparison group originated from multiple school district sites, that were assigned in the fall of year one before any intervention activities take place, and was not comprised of any school districts that had the option to participate in our project but declined to participate. Our evaluation utilized a pre-test, post-test approach in which student achievement data were collected at the beginning of the grant and at

yearly intervals of this project from both the control and experimental groups. The analysis of this data was used to determine the effectiveness of this project on student learning in mathematics.

Our project used the Mathematical Knowledge For Teaching Measures (MKT), 2007 in support of the assessment model for participant evaluation. Each participant was assessed using a pre-test, post-test design. Each participant was also required to maintain a reflective process using the lens of the Wisconsin Teacher Standards model.

Yearly evaluations of the project and its support model was evaluated by our NSDC Consultant, Linda Munger, Ph.D.

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Kenosha: Advancing Science Knowledge (ASK)

Est. 2007

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Abstract:

The Wisconsin Department of Public Instruction (DPI) Education Standards and the Elementary and Secondary Education Act (ESEA) student performance goals K-12 are the foundation of the Kenosha Unified School District (KUSD) Advancing Science Knowledge (ASK) grant. Teacher Standard #1 clearly states the importance of content, "The teacher understands the central concepts, tools of inquiry, and structures of the disciplines he or she teaches can create learning experiences that make these aspects of subject matter meaningful for pupils." The ESEA promotes that all students will be proficient or advanced by the 2013-2014 school year. KUSD Strategy #4 advances the achievement of that performance goal to 2010 by ensuring "that staff is implementing the District curriculum and using effective instructional strategies, as well as, data to help students demonstrate proficiency on District and standardized assessments."

Introduction:

KUSD and Carthage College are partnering in the ASK grant. KUSD selected twenty teachers to participate in the Broad Field Science curriculum designed by Carthage College and aligned with the Wisconsin and National Science Standards. The twenty teachers were selected to participate in the ASK grant based on the following criteria:

- Assigned to teaching the middle school science curriculum in grades 6 through 8;
- Hold DPI license or certification to, at least, teach in grades 6 through 8;
- May hold either regular or special education licensure or certification;
- Do not hold Broad Field Science licensure.

Goals and Objectives:

As a result of participation in this program, middle science teachers will:

1. Better know and understand those science concepts necessary to teach science at their grade level and beyond;

2. Design effective units and lessons of instruction based on KUSD middle school science benchmarks as well as on best practices in instruction;

3. Better understand the central concepts of science, tools of inquiry, and structures of the discipline in order to create learning experiences that make the aspects of science meaningful to students;

4. Learn how to formatively and summatively assess student work and adjust instruction according to assessment results;

5. Help students make sense of science concepts;

6. Earn an ASK Certificate of Completion from the KUSD Board of Education; and

7. Have the opportunity to complete a minor in Broad Field Science through Carthage College.

Evaluation and Reflection:

The goals and objectives of the ASK grant program are consistent with the KUSD Mission and Strategies "to empower all students to reach their unique capabilities, by providing diverse and challenging opportunities to learn through the collaborative efforts of students, families, communities, and staff."

The teachers earned college credits in the Broad Field Science curriculum and use their newly acquired knowledge of science content and methodology to improve student achievement. Data on student achievement was gathered starting in the fall of 2008 and will continue culminating in the summer of 2010.

The final result of this project will ensure increased teacher knowledge that will, in turn, positively impact student learning, content knowledge, and higher student achievement on Wisconsin Knowledge and Concepts Exams.

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Mathematics and Science Partnership Program