A Partnership of Nurturing Pedagogy: The Story of MUPET-Math

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This is a case study of an effective partnership between a university and the local school district. While the course of events was far from being smooth and highly organized, the participants and leaders involved were well-intentioned, committed, and ready to build upon a very strong foundation that took years to develop. This grant experience truly exemplified the "engaging in nurturing pedagogy" dimension of the NNER's mission for the renewal of teacher education in that it

- focused as much on student learning as it does teaching;
- showed respect for students' knowledge and their ways of thinking;
- emphasized pedagogy over knowledge;
- created a caring community of learners; and
- made connections to the community outside of the school.

It is our intention to describe the factors that contributed to the success of this work so that others may at least glean from the descriptions those ideas that could be useful in their own situations.

History of the Miami University Partnership for Enhancing the Teaching of Mathematics (MUPET-Math)

The writers of this paper would love to take credit for every detail that seemed to fall into place so naturally, but looking back, we marvel at how much this process has been a joint venture involving parents, teachers, instructional leaders, administration, university faculty, and community members over the course of at least 10 years. Beginning in 1999 with a change in textbooks for grades K-5 and 6-8, it was clear that extensive professional development and community outreach was needed. As early as 2001, in regularly scheduled teacher meetings, long term "plans of action" were developed after creating prioritized lists of concerns for how to improve the teaching of mathematics in the Talawanda School District in Oxford, Ohio. Without each of these crucial steps, a firm foundation would not have been in place that allowed the MUPET grant work to yield significant results with students, teachers, and faculty. Therefore, a description of the MUPET work would be incomplete without describing the building of that foundation and especially by illuminating how it was truly a "grass roots" effort that involved teachers from the beginning.

Pre-MUPET Foundation Building

In the late 1990s, the National Science Foundation (NSF) funded several multi-million dollar mathematics curricula projects that would renew the way that mathematics was taught across the U.S. Two of these curricula, I*nvestigations in Number, Data, and Space* for grades K-5 and *The Connected Mathematics Project* (CMP) for grades 6-8, were adopted by the Talawanda School District in 1999. During the adoption process, it was clear that while a majority of the teachers were supportive, many were ambivalent about the instructional philosophy embedded in these curricula. In *Investigations* this meant delaying the teaching of just one algorithm for each operation and spending less time practicing each algorithm repeatedly. This approach was replaced with activities that build upon students' natural strategies that develop as they investigate place value

and the different properties of arithmetic. In short, children still are exposed to the standard algorithms, but they are exposed to them later than before, after they are comfortable solving computations using many other informal strategies. For example, many students naturally "add up" rather than subtract so that 26 – 19 is solved by adding one, then adding six to get them from 19 to 26, giving them the answer of seven. This strategy is explored long before students learn the traditional "borrowing" algorithm. Students become much better at using mental math strategies as well, and paper and pencil computations are not needed as often.

In the middle school, using the CMP curriculum meant that students were exposed to open-ended problems that sometimes took more than one day to solve in order to get to the main idea for each section. CMP incorporates a "Launch, Explore, and Summarize" instructional model (Lappan, G., Fey, J., Fitzgerald, W., Friel, S., & Phillips, E., 2002, p. 16) for the teachers, and the biggest adjustment for our middle grades teachers was for them to back away from showing students how to do the math, and instead letting the students explore the mathematical questions in contextual situations. It was not until the summary time when students would share their methods with the entire class that the teachers could make sure that all the students had arrived at the same mathematical idea.

There were many professional development opportunities to help familiarize the teachers with the new materials; however, more was needed to help convince the undecided teachers in the district that the newer approaches could be effective. In 2001, the district created a mathematics instructional leader position for grades K-6 teachers. Don Gloeckner came to the district with an elementary teaching license and more than 12 years of teaching experience in Talawanda's Middle School. He had coached many of the local children in various sports, and had been very active in many extracurricular school activities. All of this "hometown" experience made it more natural for him to work with his fellow teachers in the district because he knew most of them and was well respected in the community.

One of the first efforts Don made was to meet regularly with all of the teachers to discuss their concerns about using a renewal-oriented curricula. Together they wrote prioritized lists of concerns that included the following:

- Teachers vary in their use of the program from using it exclusively to not at all.
- There is a lack of teacher confidence in the program.
- There is a concern that basic facts are not being mastered.
- Teachers find it difficult to involve parents and to be an advocate of the program.
- There is confusion about the flow of the curriculum.
- There is confusion about how to deal with algorithms.

As a result of these concerns, the Instructional leader and the teachers developed "plans of action" that included holding family math nights for parents, creating pacing charts, common learning objectives, and assessments for each nine-week term. Teachers began to confer with teachers of adjacent grades to decide how to streamline the curriculum so that activities would not be repeated, and so that there would be a common understanding of the flow of the topics.

In the 2004-05 academic year, with funding from the Talawanda-Miami Partnership, Don and I began holding book group meetings with the elementary and middle grades teachers. (By now Don's position included working with grades K-12 teachers.) The first book group of 24 teachers read *Knowing and Teaching Elementary Mathematics* by Liping Ma (1999) and had about 24 teachers in attendance. Our discussions centered around the mathematics taught in China and the United States and how teachers approached the content very differently. This began the process of developing a

flexibility and acceptance of approaches different from the ones that had been used to teach us and that we were using to teach math.

By the spring of 2006, the prioritized lists still contained the concern that there was an inconsistent implementation of the I*nvestigations* curriculum among the K-5 teachers. A new concern for *all* of the K-8 teachers was the increased pressure to produce high test scores on the new Ohio Achievement Tests. These concerns had caused many of the teachers to resort to their traditional teaching practices with the belief that students would be better prepared for the tests. The middle grades teachers also complained of the lack of time needed to complete CMP explorations in the assigned 45-minute periods for mathematics each day.

A plan of action that resulted was to begin another book study group funded with a Science Partnership Research Associates Program Grant from the Miami University's Partnership Office. This study was organized by Dr. Beatriz D'Ambrosio, a new senior mathematics educator from Miami University's mathematics department, and Don Gloeckner. The plan was to hold a six-session spring semester study of the book Y*oung Mathematicians at Work* by Catherine Twomey Fosnot and Maarten Dolk (2001). However, the book study was so successful it served as a catalyst for a one-credit hour summer workshop using the same text as the backdrop.

This group of participants, which had grown to 43 teachers and administrators, including the superintendent, assistant superintendent, and an elementary school principal, delved into what it means to turn a classroom into a mathematical community. This community would provide a safe environment for inquiry and would use rich mathematical problems. The title of the book suggests that the goal of this community is to produce *young mathematicians* who can "communicate their ideas, solutions, problems, proofs, and conjectures to one another (p. 29)." Fosnot and Dolk defined a "mathematics congress," a time when the mathematics community convenes to share these ideas. Many of our participants loved this idea and began allowing more of their students opportunities to justify their mathematical conclusions to the entire class (See D'Ambrosio, B.,

Gloeckner, D., Deahl, E., Fitch, K., Hathaway, J., & Hickey, D., 2008, for more about this experience).

There were numerous other connections made between university faculty and teachers during the 10 years prior to MUPET, but space won't permit good descriptions, so we will simply list several of them here:

- A 3rd grade teacher and a teacher education instructor created a mathematical pen-pal relationship between 3rd graders and college juniors;
- The writers of this paper arranged for preservice middle childhood education majors to visit grades 4-8 twice over the course of a semester to serve as tutors for struggling students or just to observe teaching in math classrooms;
- A teacher education professor helped identify TMS as a pilot site for the second revision of CMP and, as a result, teachers received much more free inservice professional development;
- The chair of Miami's Mathematics Department worked with a new Talawanda High School teacher to create an AP Calculus course for Talawanda students;
- Several university faculty partnered with new Talawanda mathematics teachers during their entry-year experience;
- Several university faculty and Talawanda teachers served as task-force members for the Talawanda/Miami Partnership.

These and other experiences contributed to an established partnership between teachers, administrators, and university faculty that was based upon the common goal of improving mathematics instruction. These relationships developed over many years, often initiated by teachers as well as university faculty. As we've said many times within our partnership, this string of catalytic events produced more

and larger movements within the system as we gained confidence, trust, and experience together.

MUPET-Math Planning and Design

When an RFP (request for proposal) came out from the Ohio Department of Education for a Mathematics and Science Partnership (MSP) grant in the fall of 2006, the Talawanda School District and Miami University decided to apply. The prinicipal investigators had met many times with Don Gloeckner when drafting the proposal, and his direction helped them envision the kind of professional development experiences that would be most effective for Talawanda's needs. The writers included two other school districts, but again, designed experiences specific for their needs since they were in different stages of growth as professionals.

Having worked on several grants in the past, we know that the process of conferring closely with the districts *before* writing the proposal in order to design the professional development is very unusual. The normal course of events is that an RFP is advertised by the funding agency, but the pressure to initiate grant work usually comes from the provost or deans' offices in the university, and therefore the initial efforts are by the university seeking out school districts willing to be involved in a prescribed professional development program. Depending upon the specificity in the grant guidelines, there may not be as much freedom for the grant writers to propose exactly the kind of professional development that is needed by teachers. MUPET-Math was therefore different from the start by beginning with the needs of the teachers rather than adhering to an announcement from the state or federal agency for a certain kind of intervention.

Experiences for First Cohort

The grant writers' first proposal included three school districts, two phases, and as many as three cohorts of teachers to go through each phase. For simplicity, we will describe what Talawanda's first cohort of teachers received from the MUPET grant. This cohort's experience began late in the spring of 2007 and was completed in

the spring of 2009. Teachers who participated for the entire two years could receive as many as 13 graduate semester hours of mathematics credit. (See Table 1 below)

Table 1.

Timeline of Events

Spring 2007 (1 cr. hr)	Rich Problems Thinker-Doer Problems
Summer 2007 (3 cr. hrs)	Student Interviews Thinker-Doer Problems Specific help with curriculum
Academic Year 2007-08 (3 cr. hrs)	Lesson Study
Summer 2008 (3 cr. hrs)	Specific help with curriculum
Academic Year 2008-09 (1-3 cr. hrs)	Workshops designed for each grade levels' needs

Recruiting teachers to participate in the first cohort was easy as a result of the recent successful Talawanda/Miami partnership activities in mathematics which included the book studies and summer 2006 workshop. Increasing numbers of teachers began to take part in our joint work together because they had experienced or had heard that, through collaborative efforts, the course was going to be of high quality and would specifically address their curricular needs. In fact, including the 51 Talawanda teachers participating in the first cohort of Mupet-Math, over 80% of the entire math staff in Talawanda had now become involved in the professional development work offered through this partnership. Given the size of this large cohort, we were fortunate to be able to split the teachers into groups of K-2, 3-5, and 6-10 so that the three Miami faculty members could better prepare sessions that would best address their grade level band.

Using Student Learning to Inform Teachers' Professional Development

Thinker-Doer Problems

The first spring/summer workshops of MUPET-Math focused on using students' understandings and their ways of thinking about mathematics to inform teachers' instructional planning. In the spring we began using a tool called "Thinker-Doer" problems (Hart, L., Schultz, K. & Najee-ullah, D., 2004), which were basically two challenging problems (of equal difficulty, if possible) that were used in the following way. The group of teachers divided in half so that all of one group get the "green" problem and all of the other group get the "blue." The teachers retreat to different rooms and solve their problem as a group. After they solve, they are supposed to talk more about the solving strategies used so that they become "experts" on the problem having thought about it in many different ways. Each person is now a "Thinker" for their particular problem.

When both groups are finished, they reconvene and are partnered with a teacher from the other group. The "Thinker" who solved the green problem gives it to a partner on a clean sheet and gives the "Doer" time to read the problem and asks if the partner understands the question or has any ideas about how to start. The "Doers" job is to try to solve the problem by thinking out loud. The "Thinker," who already knows the answer, is not to interfere with this thinking process but is to only ask questions that would clarify her understanding of the process that the "Doer" is using. When finished, the two partners change roles and together in the same manner they solve the blue problem.

This three-part process takes a lot of time, but we felt that it was vital in helping our teachers learn more about what it means to really listen to their students even if the teachers know a better approach for solving the problem. We found that it was often humorous how much we wanted to guide the other one to the answer. I even heard one teacher saying, "warmer, hotter…" the closer that he felt his partner was getting to a method that would work. This naturally led

to discussions about how difficult it is to stand back and let students struggle, to let them flounder in confusion for a while, often a necessary step for students to take in the learning process. Many of the teachers felt that it is very painful to watch this, but at the same time they also knew how much more satisfying it was for them as Doer if they were allowed to solve the problem on their own.

Student Interviews

Undoubtedly, the best experience of the summer workshop was an opportunity for each teacher to interview a student who would be in her grade level at the beginning of the next school year. Don was able to arrange with parents in the community for about 50 students (each matched to one of our teachers) to come to the middle school for roughly seven, one-hour sessions. This one-on-one time each day was mutually beneficial for both the teacher and student. The teachers were able to hone their listening skills and learned much about posing "probing questions" rather than "leading questions." Students were also rewarded by having someone listen long enough to diagnose where the student had struggles with mathematics, where the student had strengths, and where to take the student from there.

The teachers were then assigned a reflection assignment during which they listened to all of their interview tapes and chose significant portions where the student showed an understanding that was unexpected, or used a strategy that the teachers had not seen before. It was made clear that in this reflection we wanted to learn more about what the student CAN DO, not what the student CAN'T DO. As teachers, we often stir up negativity by complaining about the prior grade level and wondering why students come to us so unprepared. The large majority of my teachers reported being surprised by how much their student CAN DO. The following is a quote from one of the teachers,

> I was surprised by a great deal of what took place in my interview with Samuel. For years now I have been hearing about all of the strategies that students learn to apply to their multiplication, but I don't

> think I ever really believed they could use them efficiently. I loved that before I even got the first problem out of my mouth he was using partial products. I was also surprised that Samuel was able to explain almost all of his thinking with so much detail and accuracy. There really were so many mathematical concepts embedded in his thinking. The one I was most shocked by was Samuel's suggestion to use the inverse operation of division to check to see if his answer was correct on the first day.
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> Working with Samuel has helped me to see that all students knowing the algorithm is not necessarily what is most important. In previous years when we were reviewing decimal multiplication and division, I have gotten frustrated with students who don't know the algorithm and I quickly tried to tell them how to do it. From this point forward I know that I will take more time to listen to the strategies that students are using and base my teaching on what they already know. I really experienced how doing this with Samuel boosted his confidence and enabled him to make larger gains. I really struggle to do this with skill areas that I believe students should have mastered by the eighth grade. I hope to be able to allow this experience to shape the way that I review fractions as well.

Using Data and Inquiry to Reveal Hidden Problems for Simultaneous Renewal

As implied by earlier concerns, when the school district first adopted the new curricula, there were immediately many negative comments from people not familiar with the approach, people who feared that "computational basics" would be thrown out completely in favor of mathematics that involved large, open-ended problems and explorations. Don had enough foresight to begin a data collection at the end of each academic year that assessed the computation-

al skills of all students in grades 3 through 8. Since he believed that their skills would not be compromised by using the new curricula, he felt he needed to provide evidence to parents and other stakeholders to justify the new curriculum and pedagogy of *Investigations* and *Connected Math* instruction.

This data has been enormously helpful in providing teachers with insights about their teaching. As one example, the analysis showed that in the area of multiplication and division, overall student averages were lower in the sixth grade than in the fifth grade. What could explain this discrepancy? We were aware that the CMP curriculum and state standards assume students have mastered these concepts in fifth grade and that the middle school teacher had little time in his or her instructional calendar to devote to computation practice. However, our inquiry into this anomaly has revealed some other interesting facts about middle grades teachers' expectations of new students and the knowledge that students now bring to the sixth grade.

These teachers were not very familiar with the informal computational strategies and depths of understanding that their students were bringing with them to the middle school. The students had been exposed to the standard algorithm, but most often it was not their preferred method to solve multiplication and division problems. They were in the midst of developing strategies and learning how to make them efficient, some more efficient than others. Sixth grade teachers often confused this lack of familiarity with the standard algorithm as lack of understanding. The elementary teachers were spending less time on the standard algorithm and were instead preparing the students to understand each algorithm conceptually before they would introduce a procedure like long division. This progression involves learning many preliminary strategies that will accomplish the same computation, but might take more time since students would be visualizing what was really going on. So, for example, a fifth-grade student might initially solve the 2-digit multiplication problem 28×16 in the following way:

	20	+	8
10	200		80
+			
6	120		48

So, 200 + 120 + 80 + 48 = 448.

Though this method might take a little more time, many fifth grade students can use this "array strategy" effectively while also showing an understanding of the distributive property. With more inquiry into the methods used by current sixth graders, we learned that by the time they enter the middle school, the majority have not yet made the transition to the traditional algorithm. In actuality, this shouldn't be a problem since 1) These four partial products are the basis of the traditional algorithm; and 2) Students tend to eventually move toward methods that take less time and are more efficient. However, because the sixth-grade curriculum assumes proficiency in students' whole number computations, the teachers had allowed free access to calculators for many of the computations involved in the *Connected Mathematics Project* problems. Therefore, a majority of students never mastered any algorithm since they had stopped performing them.

As a response to this problem, we designed a semester hour MUPET-Math workshop for the middle grades teachers. During the fall of 2008, we explored all of the computational strategies that might be used by the current students and how transitions to the standard algorithms could be introduced. The middle grades teachers have since made great strides in helping their students make the steps toward computational fluency in the sixth grade while incorporating the conceptual knowledge that students bring with them to help in introducing new but similar topics.

This same collection of data has also been used by teachers of grades 3 through 5 so that they are more aware of the strategies that most students in their grade level prefer, and which strategies are

being used effectively by the students. This is just one example of how data can be used to provide insights into the strengths and weaknesses of any program. The task of reflecting upon test scores and other collected student work can be a vital part of helping teachers understand what knowledge their students bring to the classroom and how their students think about certain problems.

Effective Partnerships Never End

We have been encouraged to be a part of a developing partnership that has recently approached a peak in maturity and in valued and productive relationships. The story of MUPET-Math has now come to a close for Miami and Talawanda since our funding has run out, and the large majority of our teachers have participated for several years. It would be so easy to sit back and congratulate ourselves by saying what a great experience we had, and, "We should do it again sometime!" However, those of us who have watched this growth from seedling to flower recognize how rare it is to be part of a genuine working partnership with mutual benefits for all partners. We fear that "taking a break from each other" might result in missed opportunities to work even more closely and deeply together in the future.

Many changes are coming our way. Missing the joy of teaching his own students, Talawanda's instructional leader Don Gloeckner has decided to return to the classroom. Given the current economy, we worry that such positions will be closed rather than filled with another quality person. We also worry that grant money will not be as available as it was in the past. Though the future is always sketchy, it is so important to continue to look forward to new opportunities for growth.

We are entering a new school year where several of our teachers have proposed and been accepted to present their teaching ideas at the next Ohio Council of Teachers of Mathematics Conference in November 2009. We are continuing some of our smaller connections like the mathematical letter writing between a third grade class and Miami juniors in a methods class while also starting new con-

nections like getting our early childhood preservice teachers working out in the schools to tutor students in mathematics. The goal is to never lose sight of what engaging in nurturing pedagogy can offer for each participant and how much more powerful and lasting collaborative learning can be. If we are fortunate, our relationship described here will continue to thrive with or without the incentive of money or extra time, simply because the partnership has been built upon a solid foundation of trust and mutual respect, as well as on productive collaborative work that improves teaching and student learning.

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