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AUTHOR Kull, Judith A.; And Others
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ABSTRACT

This paper discusses the National Science Foundation Middle School Mathematics and Science Collaborative (MSC) project designed to help schools implement mathematics and science reform. The paper consists of descriptions of these efforts in four schools: (1) "Summer Subversion/Constructivist Conversion" is about the re-tailoring of pre-planned summer instruction in subject matter and pedagogy to meet the perceived needs of teachers; (2) "Teachers Nearly Jump Ship" describes a productive, well-organized team of teachers who collaborated with their principal and a university facilitator to restructure the way they work and teach; (3) "The Rochester Middle School Story" is about how Rochester's ongoing change from a junior high school to a middle school affected the school's participation in the MSC project; and (4) "Adjusting an NSF Project to a School Community" is about the struggle between the local autonomy of a truly collaborative school community and a tightly structured project designed to improve middle school mathematics and science curriculum. Contains 17 references. (MKR)

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# Mathematics and Science Reform Through School/University Collaboration: Fables from the Field in Four Middle/Junior High Schools

Judith A. Kull, Michael D. Andrew and Sharon Nodie Oja
Department of Education

Christopher F. Bauer
Department of Chemistry

University of New Hampshire

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Judith A. Kull
Michael D. Andrew
Christopher F. Bauer
Sharon Nodie Oja

University of New Hampshire

> It is a common idea, one often featured in introductory textbooks, that science advances by an iterative process of formulating and testing hypotheses...as some critics of this view have pointed out, even when an experiment succeeds the hypothesis that accounts so neatly for the published observations was, more often than not, arrived at after the observations were made; the faulty hunch that led to the experiment in the first place is silently relegated to an appropriate limbo. Moreover, the situation that made it necessary to adopt one method of experimentation rather than some other is seldom explained. The first-hand feel of research in this area is taken for granted. The talent for being surprised at the right moment is underplayed. The important role of serendipity is minimized. (George A. Miller, *Spontaneous Apprentices,*1977, p. xxiii)

Believing that we had long ago learned George Miller's lesson of de-sciencing educational research by not formulating rigid hypotheses or wedding ourselves to pre-conceived notions but focusing, instead, on people, contexts, and real-world problems, our NSF-sponsored Mathematics and Science Collaborative (MSC) adopted a collaborative action research framework for effecting reform in four middle/junior high schools. Drawing on the work of Kyle and Hovda (1987), Oja and Smulyan (1989), Cochran-Smith and Lytle (1990, 1993), we viewed teachers as researchers who would provide practical knowledge of the problem that we had all chosen for study: How to reform the teaching and learning of mathematics and science in public school classrooms. University researchers would become developmental facilitators, providing their expertise in working with children, subject matter, and assessment; collaborating with teachers to identify and approach problems from multiple perspectives; gathering and analyzing data; helping to develop solutions; and offering technical assistance from our various fields. We assumed a "work with" rather "work on" posture, recognizing and valuing the unique skills and insights of individual teachers, administrators, and university faculty. Because of the collective experiences

were undergirded by recommendations put forth by the National Council of Teachers of Mathematics (NCTM) (1989; 1992), The National Science Teachers Association (NSTA) (1989), the American Association for the Advancement of Science (AAAS) (1989;1993), and the National Research Council (NRC) (1994). Our objective was school-wide, sustained reform rather than isolated curriculum tinkering or packaging that might end up on the bottom shelf. This view highlights an important goal of collaborative action research -- change. We believed that our precise methodology would fall somewhere near the middle of a change-initiation continuum holding administrative fiat at one end and teacher-initiated reform at the other.

"Energy" was an integrative theme framing school-year activities and three-week summer institutes rich in content and constructivist pedagogy. NSF expected us to excite teachers with new knowledge, send them back into their schools, and, with the collaboration of university science and mathematics faculty, make good things happen for children. We are halfway through the second of four years.

The way in which the project is developing is achieving initial goals, but not in the way that we convinced NSF it would. Change is being played out in different ways and at different rates at each school. It is strongly influenced by apparent and not-so-apparent school contexts, issues of project control, and by the working relationship between the university faculty facilitator at each site and the site's teachers. It is characterized as much by concern about school structure and effective time management as about curricula and lessons; by negotiated expectations as project directors attempt on the one hand to support teachers' desires to pursue their own interests, and, on the other, to seize the teachable moment to guide both school and university teachers in new directions. Its metaphor is the activity-centered classroom -- the kind this reform is about -- where collaborative groups working on individual projects are assisted and prodded by instructors on an as-needed basis. It can be an emotional rollercoaster for everyone.

Here are the four fables which provide the details of our progress toward change.

## Fable One: Summer Subversion/Constructivist Conversion

Christopher F. Bauer

This story is about the re-tailoring of pre-planned summer instruction in subject matter and pedagogy to meet the perceived needs of teachers without abandoning overall project goals. It is also the story of how a university chemistry professor became a teacher advocate and ally.

The intended summer schedule was a well-planned piece of the original proposal, neatly moving our teachers through a sequence of content instruction centered on the theme of energy. University science and mathematics faculty would model hands-on constructivist pedagogy during the first two weeks. In week three, morning sessions would focus on the adolescent learner, adult development, and teacher leadership. In the afternoon, each school team would work with university faculty to begin planning specific curricular units and schedules for the school year. What a wonderful way to kick off the project in July! Unfortunately, the funding did not arrive until September. We will never know exactly what was lost during the Summer of '92.

With our best-laid plans in the trash, we attempted to make headway during the busy school year. I am the university site facilitator for Dover Junior High School, and an associate professor of chemistry. Having never done anything exactly like this before, I often felt like the proverbial "rushing fool." I have continually been redefining my role (conduit? champion? gadfly?) in an attempt to facilitate change at Dover, something that the teachers there had nominally agreed to do. I felt I had to meet with them -- four mathematics and four science teachers from the 7th and 8th grades -- on a regular basis. This was no mean feat. Even with one of the teachers as a site contact,

communication was laborious and nearly nonexistent. Finally in February, I wrote each teacher a letter indicating my concern about the lack of movement and strongly suggested a meeting. Although a bit strained at first, this got the ball rolling, and I began to visit them more frequently during the Spring.

After my "wake-up" letter, I met on March 1st with the 8th grade teachers. They wanted to hatch some ideas during the remainder of the spring, use the summer to develop them fully, then put the pieces to work in the fall. They asked: "When will the institute run? What if someone can't make it the whole time? What will go on?" They also felt strongly about using some of the time to pursue their own agenda. I got the impression that their attitude toward the summer was guarded. This was confirmed by the site contact teacher. I wondered if this were a sign of a lack of commitment to making change happen, in the sense of making necessary sacrifices, despite their comments that "We're ready to go philosophically." In response to their ideas regarding summer, I did not respond because, after all, we had a perfectly good, well-organized plan (which they had approved in the proposal submission) that didn't get used last summer.

On March 19th, participants met to focus on the meaning of math/science integration and how it might look in the classroom. To help make the issues more concrete, teachers were challenged with an activity requiring them to construct a balance (adapted from ESS Kitchen Physics). I missed the meeting, but I didn't miss some of the feedback from the Dover teachers. A number of people felt that it was a waste of their time -- mildly interesting but not pertinent. The issue of time was emerging more and more as a dominant theme in engaging teachers in school change and in maintaining momentum. This incident may have sparked the following conflict.

In mid-April, the detailed summer institute plan was placed in the teachers' and principals' hands, along with a polite request for suggestions. The subversion began.

At my next routine visit to the school, teachers individually and in groups had a chat with me, concerned that the summer plan would do irrevocable harm to the school/university collaboration. They weren't angry -- just concerned about the value of the time to be spent. They obviously were not interested in a whole summer full of activities like "Building Balances." My journal paraphrases their comments:

> Dover Junior High School is at a critical point. The summer activity makes it or breaks it. If they aren't able to spend a substantial portion of the time working on their own concerns, we are highly likely to lose them. They're looking at going right from the snow-extended school year right into the institute. They are not totally free from other claims on their time. I f they don't come out of this summer with a good feeling -- having done something fun, learning, and productive -- the project is doomed. We'll never get them back for another summer. The one thing they are looking forward to is having the time to work together. If they don't feel the time is well spent, all the stipend in the world won't get them there. But if the time is productive, they wouldn't even care if they got paid (so someone said). The original summer schedule simply isn't going to work. "It may be wonderful for somebody. But not for us." There was also the statement that if we don't like what you're doing for us "we can do it without you."

After some thought that night, I arrived at an alternative plan that seemed to address the issues raised by the teachers. I presented it, with a bit of trepidation, the next day at an MSC staff meeting. I was nervous because I was about to suggest that a carefully crafted plan -- one okayed by NSF -- be set aside. My written notes:

> If we believe in constructivism as a base for decision-making, then summer should:
>
> - o start from where each team is
> - o allow them to explore their understandings of their projects
> - o seed this work with expert advice and with injection of higher order questions concerning teaching and learning and what integration of mathematics and science may mean
> - o provide content on an "as needed" basis
> - o the focal point remains the team and its ideas throughout the institute -- this will develop commitment to each other and to the goals of the project.

Subsequent discussion with my UNH colleagues confirmed that the other school sites were also having misgivings about the structure of the summer institute. We also had the feeling that the new plan was delusional -- how were we going to manage plugging teams and people in and out "as needed" over a three-week period and achieve some concrete learning goals? We bounced the ideas off other colleagues and received enough positive feedback to believe that we could actually make it work. But, as one UNH collaborator mentioned, it was extremely hard to "let go:" Aren't we the experts? Shouldn't we be able to tell the teachers what they need to know? After awhile, however, it began to feel right. The institute was beginning to look like a model for a constructivist classroom.

A Summer Steering Committee was convened on May 6th with representatives from each school to help define how to accomplish this vision. A consensus emerged, "oozed" was the term one teacher used, regarding the broad features of the summer plan. On May 20th, most participants came to UNH for a day of sharing and summer planning. The day's structure had been crafted by the MSC staff in consultation with an Education Department faculty member experienced in group dynamics. School teams gave capsule status reports, were presented a list of summer activity options based on their previous planning, talked with potential UNH resource faculty, and began to define their team goals and activity sequences for the institute. At a follow-up Steering Committee meeting, a tentative calendar "broken down by the content areas that the sites expressed an interest in, matched with the names of the resources and the dates that they are available" was reviewed. A blank scheduling form, constructed by one of the school principals, was sent to the schools along with this "availability schedule" of UNH faculty and teacher consultants. Each team submitted a schedule indicating what and when they desired specific content pieces, consultants, and team planning time. A "final" calendar was created by collating the returned material and embellishing it with a few things we wanted to push certain teams to consider. It was

now ten days before the institute was to begin. We made specific plans for the first three days and sent this schedule to each teacher.

Even the negotiated schedule didn't remain. We continually molded the schedule to the evolving needs of each school team. Figure 1 shows a sample of the working schedule.

The institute had the following features:

- o Teams were always together and followed an individualized team plan.
- o Half-hour common time at the start of each day was used to lay out plans for each team. Daily schedules were posted on the wall for all to see the evolution of activity throughout the week. This documented the actual, versus planned, schedule.
- o Time blocks were 1.5 hours in duration.
- o Activities included focus on science/math content, constructivist pedagogy, field work, library research, gender and learning, staff development, assessment, team building.
- o End-of-the-day team meetings were held with site supervisors.
- o MSC staff met formally every other day (and informally "in the hallway") to review teams and to modify team schedules.
- o Teams shared progress reports during the common time in the third week.
- o On the final day, there were team summaries, "team diagnoses," and suggestions from the MSC staff regarding their future.

Besides letting the team schedules evolve, the MSC staff used the end-of-day team meetings and the final-day meeting as places to become more overtly directive. The staff also participated along with the teachers in most of the summer activities.

The question can be asked: Why didn't you just say "take it or leave it" regarding the summer in order to fulfill the original project commitment, ensuring that both mathematics and science teachers were exposed to substantial content? The

counter-question must also be asked: Who is likely to return to school more refreshed and ready to take on the challenge of change, a group of different individuals all put on a single tour ship with a fixed sailing schedule and rigid daily routine of activities, or a group allowed to take a number of smaller crafts and lay out their own itinerary from a set of varied possibilities and with the assistance of knowledgeable tour guides who push them to take some risks? We think the second question is the more important one, and the second group benefits the most.

## Fable Two: Teachers Nearly Jump Ship!

Judith A. Kull

This story is about a productive, well-organized team of teachers who are collaborating with their principal and a university facilitator to restructure the way they work and the way they teach. It seems as if it has always been this way, but it has not.

> I think the project has now gotten to where I thought it was going to be, but it has taken a year. I was hoping it would be hands-on work with other teachers in our building -- coordinating math and science. We didn't really start there. We started out doing lots of hopping around, I guess, trying to figure out what we needed to do. Lin Roy.

Where are we? What was the process that allowed progress toward project goals? Below is a snapshot depicting the current status at the Exeter AREA school site. Lin Roy draws upon her own experience but speaks for the five other MSC teachers at the school. Following her narrative is an explanation of "how we got there," recounting the barriers and enablers that effected the transition from autonomous teachers with doors closed who were teaching standard curricula and using standardized evaluations to teamed teachers with doors open asking hard questions about curricula, tracking of students, relevant experiences, and authentic assessment.

In the snapshot, Lin describes a lesson in which she and the mathematics teacher, Diane, combined two "upper" and "lower" homogeneously-grouped classes in a hands-on activity involving estimation, distinction between quantity and value, graphical data representation, and communication of experimental results. On many levels, this integrative, collaboratively-developed lesson represents a significant and ongoing departure from the previous status quo at Exeter AREA Junior High.

> Actually, my class went in and taught her class... Diane wasn't sure how it would work. She thought as soon as my threes (lower-ability-grouped students) -- these kids have been together; they know who's the top of the class and who's the bottom -- as soon as they saw these kids coming in, they wouldn't pay any attention, but that didn't happen. There was no problem at all. Then we did a project together of measuring coins, estimating how thick a coin is or if a penny is this thick, how can we estimate the thickness and value of ten of them? We graphed the information and talked about how we could share the information and did a lot of group activities with it. That worked out very well. And the interesting thing was that they had to do a presentation at the end of it using an overhead showing their information and what process they used to figure out. ...The thing that surprised both Diane and myself was that my class -- (my) students -- were picked to do the presentation with the overhead just as much as her's was....I don't think the kids have as much problem with it (perceived differences in ability) as the adults do.

The setting in which Lin and Diane teach is a traditional junior high school with autonomous teachers, subject matter departments headed by department chairs, and academically tracked classes in the sixth, seventh, and eighth grades. The community is primarily white-collar and affluent, but the school also draws students from elementary schools in the surrounding blue-collar towns. Parents are generally happy with the school as it is, but the teachers and principal saw the NSF project as an opportunity to make positive internal changes without outwardly rocking the boat. The university connection would legitimize teaming efforts, curriculum integration, and a shift from teacher-centered teaching to student-centered learning.

The principal is unusually sensitive to the individual needs and concerns of children, teachers, parents and the community at large. He makes a practice of acknowledging every contribution, award, special effort, or accomplishment by writing a letter of congratulations or by publicly calling attention to the event. He also is very aware of personal and professional issues that affect his staff and provides individual encouragement and support when they need it. As the co-director of the NSF project and the eventual university liaison to the Exeter site, I experienced this support firsthand and appreciated the principal's straightforward, encouraging style. At the start of the project, he agreed to provide teachers with released time for meetings and conferences, some supplies, and alternative scheduling if needed. He did not specifically articulate these possible actions to the teachers, but they understood his general posture. The principal wanted ideas and requests to come from the teachers themselves, not from him, and hoped that the NSF project, and particularly the university connection, would foster some level of teacher empowerment.

The teachers who chose to be involved in the project are bright, strong committed veteran teachers, "very stable." They are well-grounded in their subject areas and enjoy working with junior-high aged students, appreciating the challenges while displaying an easy rapport with the children. They also are used to working in an autonomous fashion, drawing upon common goals per subject and grade level, but adapting curriculum through individual lesson planning and implementation. Coordinated lesson planning and integration of mathematics and science subject matter constituted a major change in the way these teachers would have to go about their work. At the start of the project, the principal and department heads estimated that the the teachers' comfort level with this kind of change "would score a 6 out of 10." The math teachers who had been involved with the NCTM standard-setting process understood and appreciated the value of change. The science teachers were willing to change if they "saw a good solid reason for it, both in the short term and long term."

Three of the teachers had been to a "critical skills" workshop the previous summer and were positively disposed toward collaboration and the implementation of constructivist pedagogies.

Initially the teachers described their expectations of the university in concrete terms: give workshops; pay for substitute teachers; provide resources, free courses, and guidance about goals of the project. They also voiced skepticism about the university's stance: that university faculty were out of touch with the junior high school, did not value or model collaborative learning in their own courses, and might embarrass teachers who had been away from difficult subject matter for awhile by requiring mastery of large quantities of mathematics and science content rather than listening to what the teachers themselves felt that they needed. Despite this level of suspicion, the teachers hoped to enlighten the university faculty regarding real-world school possibilities and constraints while, in turn, gaining valuable resources.

Despite these positive attitudes and willingness to articulate and surmount perceived barriers, the Exeter group had trouble getting started. The university liaison, a field-experienced doctoral student, met weekly with the group to describe support opportunities, provide resources, and encourage the group to develop a plan. The teachers, however, remained unclear about how the project goals related to their setting and were frustrated at not finding a good place to begin. Reviewing each other's textbooks and short discussions about who did what in the classroom did not help the science teachers gain an understanding of the mathematics curriculum at each grade level and vice versa. They described meetings as "going in circles" with "no direction or leadership." Mistrust concerning the project and the university's role began to brew and reached a culminating point following the Build the Balance workshop which was developed by me and the Exeter mathematics department chair who was on sabbatical leave, working at the university. The teachers felt it was "a nice activity," but disconnected from their own curriculum and having nothing to do with

their own problem of how to get started. They became visibly upset when their math department chair and the doctoral student who was serving as the UNH-Exeter liaison wanted to administer a questionnaire to fulfill a course requirement. The teachers balked. They felt that the NSF project was a "set-up" to do research on them while providing unneeded resources. They saw no hope of getting the university to listen to them and make change happen. They were ready to "jump ship" but agreed among themselves to give it one more try. A spokesperson for the group called me, described the frustration they were feeling, and asked if we could all talk about it. The other co-director and I went to the school to meet with the teachers. I also met separately with the principal.

At those meetings, it became obvious that just getting together was a hardship for the teachers. They had been stealing "group time" from the early morning and late afternoon hours amidst busy professional and personal schedules. There was no common planning time. As a possible solution, we initiated and supported the formation of math/science teacher pairs for planning and implementing a few lessons rather than trying to accomplish full-team curriculum planning. I agreed to take over the liaison role and meet regularly with the two-person teams to help plan their lessons. I also kept the principal and vice-principal informed and was able to garner administrative support such as securing released time from "hall duty" for one of the teachers so she could meet with her team-mate. During that first year, the teachers encouraged me to continue in these roles of co-lesson-planner and negotiator. Thus, grade-level pairs were developed, common time was found, and joint math-science activities were planned, implemented, and critiqued. The teachers reported that they felt "encouraged and supported" by this new plan, had gained a "sense of self-direction," " felt a sense of accomplishment," and were "finally moving forward, not in circles." They saw my invited intervention as a turning point because it occurred on their turf, under their terms, and became an ongoing vehicle for dialogue that valued

the contributions of all involved. There still was some distrust of the university and some competition among teachers. The teacher-pairs were working well, but they were isolated from each other.

As the spring went on, a number of positive goals were set and met. Of particular note was the amount of mathematical data collection, analysis and display at the annual science fair. Without knowing that this had been an explicit goal, one of the judges, the science consultant from the New Hampshire State Department of Education, remarked on the excellent use of mathematics in the children's projects. He saw this as a big change from the previous year's work. The teachers were ecstatic, admired the work done by students in all of their classes, and vowed to find a way to operate as a full team the following year. They decided to use the summer to initiate and build TEAM EXETER while continuing to develop curriculum with their original partners. By the end of the summer, they felt empowered enough as a team to meet with the principal and vice-principal to request common scheduling time and common back-to-back teaching blocks with shared students. They requested help from a university professor, Charlie, who specializes in team building and asked that he join them in their meeting with the school administrators:

> We met with Charlie before Tom and Joan arrived. We had planned our strategy as a group beforehand and really just needed positive reinforcement from Charlie. Also we needed him with us when we met with Tom and Joan as a security net. Lin was our spokesman. She is to the point and doesn't appear to need the limelight. Great choice for the job! She was super!

I remained supportive but not directly involved. The group won a reasonable compromise from the administration who scheduled common planning time for the upcoming school year and promised to use NSF funds to restructure the school day to meet the teachers' needs during the next academic year. At the team's request, I found the appropriate NSF budget category and negotiated with the administration.

This year we meet weekly as a team. The teachers set the agenda, keep the minutes and "call the shots." My job now is to collaborate in overall planning; provide resources; and work with the teachers in the teaching and assessment of integrated math/science lessons. Currently the group is rethinking its own expectations and rules, trying to figure out what has been accomplished, where to go next, and how to work with several teachers who have voiced an interest in becoming a part of TEAM EXETER.

## Fable Three: The Rochester Middle School Story

Sharon Nodie Oja

This is the story of how Rochester's ongoing change from a junior high school to a Middle School, which began in 1990, affected the school's participation in the MSC project which began in 1992. This effect was not fully anticipated by an enthusiastic principal, hopeful teachers, or collaborating university faculty.

Success stories sound clean, tidy, and have finished, packaged products. This story tells the complexity, the stumbling blocks, the difficulty of the process, the unsolved problems, amidst the "doing" of integrated mathematics and science units at Rochester Middle School. Our intention is to provide a compelling story on the less predictable nature of school change. It is like painting a picture as opposed to taking pictures.

Assets of the new Rochester Middle School re-organization revolved around new school climate goals that allowed frequent communication among staff and between staff and administration through a teaming arrangement of teachers, encouraged teacher experimentation and change, and involved teachers in decision making on policy and curriculum as each team became responsible for the same group of students over longer periods of time.

Early in the first year of the project it became apparent that the new school's philosophy -- a strong belief in teaching the whole child, recognition of the early adolescents' movement from concrete to more formal stages of cognitive development, a school within a school concept with teams of four subject area teachers responsible for different groups of children, etc. -- was at odds with the philosophy expressed at the high school. The high school wanted a mini-high school, a junior high school. The high school teachers were worried about content coverage and claimed the middle school graduates would not be prepared for the high school climate, nor the high school course work or variety of different teachers at the high school. The conflicting philosophies created enormous outside pressure on the new middle school.

In the principal's initial interview he described more about the transition.

> ... ten science classrooms this year, eleven next year, and twelve the year after that... Of the four new science people, none of them are certified in science. All are elementary certified, yet not all teaching sixth grade. Two are teaching sixth, one teaching seventh, and one teaching eighth. And so you have a very wide range of professional background...I think the content area in the MSC project is going to be good for our experienced middle school staff to freshen their knowledge. Most of them were science majors but most of them haven't been in a lab for a few years, some of them forty-five years. ... We have people currently teaching middle school science now who have never taken a college science course.

The principal went on to describe the ten mathematics classrooms and teachers in the same way. He hoped that the MSC project would focus on upgrading teachers' content knowledge, first, and, then "if our people are more comfortable with some of these topics, they might be more willing to experiment with some techniques."

An analysis of documentation from Rochester Middle School's first year in the MSC project includes themes of pessimism, fear, and worry exhibited in team meetings in the fall and a growing hopefulness in the spring that teachers could use the MSC project to "fight back," to prove and illustrate the worth of the middle school concept for teaching and learning in mathematics and science. The Rochester Middle

School mathematics department chair's initial comment in the fall of the first year illustrates a collective concern:

> They (the high school, the school board, some members of the community) don't want to hear my voice anymore ... It is the mathematics faculty at high school versus us at the middle school... The whole middle school idea is in jeopardy from above and outside ...and strategic planning for the whole district is focused on a K-12 curriculum in mathematics.

During the first school year, as MSC project co-director, I attended an early meeting with the Rochester team in which I learned first-hand about the pressures this school and team were experiencing. I could see that these school context and school climate issues were paramount and that the team experienced them as inhibiting them to "do" what the MSC project was "supposed to do." I encouraged them to investigate ways that the MSC project could help them deal with these issues in their own school district. They acted on the suggestion of consulting an education faculty member with expertise in science education and curriculum development to help them think through further possibilities. With his help the team framed the history and context of their worries and developed options and strategies that would take advantage of the school-university collaboration. Plans included videotaping mathematics or science lessons to provide evidence that the middle school was successful in educating early adolescents in ways that would positively influence their later learning of high school mathematics and science. The team planned to show the videos to the school board and community members. Investigation was to include reviewing the NCTM Standards for the Teaching of Mathematics and the upcoming science teaching standards to help systematically counter the attacks from the high school.

Another issue dealt with ownership of the MSC project . Which of twenty mathematics and science teachers would be involved? Would the collaborative be formed by subgroups of the twenty or would the whole school be involved? This site

has continually attempted to involve all the middle school math and science teachers, looking forward to more interdisciplinary work within all the school teams. Even though the project plan called for six teachers to become involved during the first year, Rochester identified twelve who would be paired, one science with one mathematics teacher. Nine attended the summer institute.

The Rochester group of nine exhibited measured optimism in the beginning of the 1993 MSC summer institute. Summer institute documentation illustrates again and again the goal of involving all the mathematics and science teachers. On the second day of the institute, for instance, the Rochester team meeting agenda focused on the following:

> How do we encourage other faculty members at Rochester to jump on this bandwagon? Five of the eleven teacher teams at Rochester are represented at this summer institute for MSC, but six teams are not represented. How do we get funds for materials, math/science activities, source grants so mathematics and science teachers on all eleven teams at Rochester Middle School will be involved?

The mathematics and science teachers who rarely saw each other during the school day got to know one another in some significant new ways as a result of the summer institute. They discussed adult learning models, staff development practices, effective communication skills, productive team meeting skills, and workable school change strategies. Pessimism was heard when they recalled the isolation they felt during the school day and the difficulties in finding time to discuss curriculum because priority was given to the more immediate topics of middle school philosophy, students and discipline, homework concerns from parents, pressure from outside, etc.

Involving their school administrators during the third week of the summer institute paved the way for organizational support in developing two-person math/science partners to plan and try out integrated curriculum units in their classes the following year. These pairs would then become models for the remaining mathematics and science teachers who were not involved in the MSC project. The

team ended their summer reflection by writing: "RMS team members are spending the next few weeks on individual reflection before coming together again as a group to share their growth with the entire RMS community."

The team designed a schedule for the 1993-94 school year with regular monthly meetings. They promised each other that these would take priority over all other after school meetings at the school (except for emergencies). They would keep a written record of all meetings, rotating facilitator and recorder roles among themselves. They would set a structure for staff members to collect and add lesson units that they had tried out. They said they needed to form a parent/teacher group to inform parents of what they were doing in mathematics and science and how they were smoothing the transition for the children from middle school to high school. They would keep the monthly meetings open and invite any of the other interested mathematics and science teachers to attend.

Despite a willing spirit, in this second year of the project the Rochester teachers continue to have difficulty finding time for partners to work together and plan. One teacher said, "I am most concerned about , and as you both just said, time to work with your team mate to do a collaborative project ... I find it very difficult to find time to create." One suggested, "If we could find time during the day to meet, or just free up people so we could work, it would be so nice. Time is just such a factor." Another teacher added that he didn't even have time for lunch. There is a sense of loss of the goals that they had planned last summer and the loss of energy that they had felt at the end of the institute.

What does it take to fight back? For this team, in the second year, the most successful enduring experience with the MSC project has been the one-on-one meetings with the university liaison who, prior to joining the project, was the mathematics consultant for the New Hampshire State Department of Education. He serves now as consultant to the individual Rochester teachers about their teaching

and curriculum, visiting the school for one full day every two weeks. Because not all team members have been able to regularly attend their scheduled monthly meetings, and because the university liaison has a scheduling conflict prohibiting his attendance, he has, for now, abandoned the large-group goals of the grant. Instead he has begun to focus on working with individuals and a few two-person teams, relating his conversations directly to in-class observations and to teachers' specific lesson plans. He works very much like a teaching supervisor or mentor, a different role from his three counterparts at the other MSC school sites. He has found a niche within the Rochester school context and with the MSC project members that makes him very welcome and appreciated. "Ferd is really an invaluable asset," said one of the team members.

## Fable Four: Adjusting an NSF Project to a School Community

Michael D. Andrew

This story is about the struggle between the local autonomy of a truly collaborative school community and a tightly structured NSF project designed to improve middle school mathematics and science curriculum.

Deerfield Community School serves nearly 500 students (first through eighth grades) in a clean, well-designed, modern, building located in the midst of a rural woods area of southern New Hampshire. The faculty share a distinct and clearly articulated preference for a child-centered, cooperative learning community. Although a few teachers question the primarily humanistic philosophy, and a wide range of ability to teach in a truly child-centered way exists; there is unusual uniformity of purpose in the school. The principal, who has been at the school for 15 years, is a gentle, quiet, but charismatic man with intense energy and sense of purpose. His humanistic vision and quest for continual improvement and educational excellence is

clear to everyone in the school and the community. He provides strong moral leadership. He speaks and acts in concert with deeply felt values of child centered learning facilitated by a community of empowered teachers and staff members. In Deerfield, site-based management is more than a slogan--it is a way of life. Group process is an overriding concern. Positional authority is virtually non-existent and teachers are accustomed to speaking their mind.

The curriculum is uniform in style and goals but varied in content. A whole language approach and thematic teaching permeate the school. Still, there seems to be great diversity in curriculum. The paradox is that a community of empowered teachers has led to a core philosophy but tremendous variation in content among teachers of the same grade and subject. Curriculum content continuity and sequence is somewhat weak. The teachers and principal are aware of this and are working to more tightly sequence the curriculum and find some unifying themes around which to integrate curriculum.

Teachers have an unusually sophisticated view of curriculum and have participated with community members in developing a well thought out curriculum model. It begins with the Deerfield Vision for learning developed by community-wide participation on "The Big Picture Committee." The vision centers on developing the whole child, and details the major skills or dispositions that are "vital to becoming a self-directed, resourceful life-long learner." The carefully worded "critical skills," include such things as problem solving, decision making, critical thinking, creative thinking, communication, organization, cooperation, collaboration, management, leadership, independent learning and documentation.

The vision statement is being translated into educational goals and outcomes and will finally delineate total community-based actions to support learning.

At the school level, teachers have evolved a model for curriculum which draws heavily from Brian Cambourne's book *The Whole Story*. The Deerfield model

describes an Essential Environment in which immersion in the subject is interwoven with the essential skills ("Actions") of learning/doing a particular subject. The result is ENGAGEMENT--the goal of successful curriculum. The model is heavily centered on the nature of the learning process. Content, ("Essential Understanding") is the vehicle through which the essential actions of a discipline are developed.

The faculty of the Deerfield school was in the process of applying this model to the language arts/literacy curriculum when the NSF project began. Their approach was to immerse the entire faculty in the process of writing. They experienced the model and then tried to apply it to their teaching.

The same process is now going on in math. Next year, science is targeted.

There is tremendous concern in the school for maintaining procedures which include everyone in decision making. Indeed, progress in curriculum development is often bogged down by long discussions of process. Several examples will illustrate. Early in the project an issue arose that has resurfaced many times. A team member voiced the concern "We need to avoid resentment in the staff that we are a small group deciding the focus and goals for the entire staff."

In another meeting a lengthy discussion of process followed a discussion of curriculum outcomes.

"Isn't this committee just for math/science? Haven't we jumped to something bigger? Is this okay?"

On an other occasion, a teacher charged to hire a speaker for an inservice day could not complete the task without group consensus on every aspect of the assignment. How should we pay? How long should the speaker talk? Should we instruct the speaker to deal with pattern first, or geometry first?

Predictably, the next concern was whether the present committee of eight faculty should make these decisions or should the whole faculty be polled. How should this be done? By memo? In our communities? (Communities are subsets of

the faculty who cut across grade levels and who meet weekly or bi-weekly to discuss a variety of curricular and school issues and to cooperatively plan.) It is not unusual for nearly half of every meeting to be spent discussing group process. Who should make this decision? Has the whole faculty authorized this group to deal with this issue? How can everyone be involved in a discussion of our ideas?

The current curriculum committee chair is a facilitator. He sets the agenda and gently reminds the group of the agenda. He errs on the side of hearing everyone out and the concern with the group's authority seems to be diminishing. More time is now being spent on non-process issues.

The empowered faculty zealously guard against compromises of the notion of community. They are uneasy with delegating decision making, and they hold no place for hierarchical or positional authority. Authority is earned by the force of ideas, personality, exemplary values, and consistency of action. The principal has earned his authority. He seldom needs or uses positional authority.

In this environment, the positional authority of a college professor and the predetermined structure and dollars of an NSF grant carry no weight. They too must earn their place.

Early on I was asked to speak at an all day inservice meeting. I was supposed to react to the recently developed curriculum model, "Give us feedback on our framework for our writing curriculum." I proceeded to ask the committee what was important to them about curriculum. This seemed to please the committee, and I learned a great deal from the ensuing discussion. I spent the next two weeks reading the background references and writings of the faculty's curriculum framework. At the next meeting, the real agenda for my appearance before the faculty became apparent. A member said, "I hope you know, you're on trial! The staff doesn't know you."

A few days before the inservice trial I learned that each member of the faculty had developed his or her own representational model of the curriculum framework. I

went to work. I developed a three dimensional model which integrated the major aspects of their model. I drew my model for the faculty and explained what it meant to me. The feedback was clear--doing myself what they had done was the best part of my presentation. I had achieved some credibility, at least as a part-time member, or perhaps as a guest of the community. I still feel like a guest--welcome--but not an integral part of the community. To become a full member I would have to live and work in the school. I could never make it with one or two days a month.

The NSF project was also on trial. Although the school had enthusiastically bought into the project in the planning stage, there was a strong skepticism and resistance to the possibility that the grant would not fit the schools needs or that the grant activities would try to dictate what the community should do.

The comments are clear:

December 1, 1992 *"We must have a clear plan so we can negotiate the grant."*

February 4, 1993: *"How can we use the summer program to fit our own goals?"*

There would be no pressure applied by the site team for anyone to participate in grant activities. There would be no compromise of community plans. Could the grant fit in? Would a team even *go* to the first summer session?

It was decided that a team would attend the summer workshop and they would ask for help in achieving *their* goals of designing a process oriented math curriculum.

The NSF project directors adjusted the summer program. The Deerfield team got the help they wanted *and* they also brought back many ideas that didn't appear to exactly fit their math curriculum agenda.

They continue to make enthusiastic and effective use of the project to meet their community curriculum needs. The dedication to communication, and commitment to total faculty involvement in the use of grant resources has made the NSF project

contribute significantly to improving the schools math and science curriculum development.

## Conclusion

It is apparent that our collaborative action research efforts during the first two years of a four-year project have centered mainly on various aspects of school restructuring. We did not anticipate this. We expected to directly implement reform efforts in classrooms and focus on documentation of change as it affected teachers and children. We expected to accomplish this through an organized set of activities emphasizing the content and pedagogy articulated in current reform literature. Despite our "work with" rather than "work on" posture, our commitment to school-year collaboration, and our sensitiveity to the importance of local contexts, we did not expect to become so closely involved with our four schools, so integrally involved with their communities. In truth, we expected a collaborative "governance" structure but found that control really had to come from the teachers. We think that these shifts have set us on a course of achieving our initial goal of "school-wide, sustained reform rather than isolated curriculum tinkering or packaging that might end up on the bottom shelf." The process has resulted in changes, to varying degrees, in student experiences; professional lives of teachers; and school governance, management and leadership -- areas postulated as criteria for school restructuring. (Barth, 1990; Johnson, 1990; Newmann, 1991)

To be successful the NSF Middle School Mathematics and Science Collaborative project has responded to the uniqueness of four very different school site settings. The response has been analogous to current descriptions of how teachers should work with the individual variation found in the

classroom. The curriculum, while preplanned to the best of the project directors' abilities, had to be modified. Specificity and coverage were sacrificed to meet important local goals. Our project was designed to improve middle school mathematics and science instruction for children. Our curriculum had to adjust while keeping this goal at the forefront. Our process had to fit local cultures.

Instructional plans must take into account the learner's needs, interests and experiences. Our project intended to provide certain predetermined experiences in the first summer session. We soon learned that it was more important to provide the resources and assistance that each individual school needed. It was this shift in thinking about instructional planning that produced real change.

The role of an effective teacher varies with the nature and needs of the learner, the school context, and the nature of the desired learning. Teaching styles also take into account the strengths of the individual teacher.

In our project four site coordinators evolved four different styles in response to schools with differing needs, schools operating at various developmental levels regarding change and restructuring.

At Dover the pressure existed to demonstrate effective practice to the site's teacher-team. The UNH site coordinator, an outstanding college chemistry teacher with understanding of science needs, became a teaching partner on the team and an advocate for his teammates' special needs. The team itself galvanized around the idea of planning a summer institute experience for all participants that would support school-based approaches to curriculum planning.

At Exeter the UNH site coordinator, a science educator, served to provide leverage and direction for teachers who wished to restructure staffing patterns.

The site coordinator helped by legitimizing teaming efforts and by providing opportunity for previously autonomous teachers to build themselves into a team over the course of the first summer and second year of the project. As the team gained power they tackled the tough issues of alternative class scheduling, modification of academic tracking, curriculum integration, peer observation, and changes in pedagogy.

At Rochester, due to the overriding press of outside demands in a new school, the site team was unable to function effectively as a unit. While efforts continued to help with team building, the UNH site facilitator adapted his role to that of individual teacher consultant. As a math instructor this was a natural strength. As team work emerges, his role will naturally shift. Meanwhile, the group holds out a vision of thoroughly implementing a middle-school philosophy consistent with reform efforts in mathematics and science, illustrated through successful team-teaching of those subjects.

At Deerfield the tight community structure, prior achievement of site-based management, and clear school goals placed the UNH site coordinator, a curriculum process specialist, in the role of facilitator with much of his time spent on supplying resources and assistance to the team in clarifying the steps in its own curriculum development process. The team has begun to digest and assimilate reform recommendations regarding content rigor and authentic assessment in science and mathematics into their school-wide curriculum frame.

Individual, site-specific needs called for site-specific responses in order for the project's overall goals to be realized. Our experiences provided the "first-hand feel of research," offering the challenges and rewards of surprise and serendipity. Change has occurred at varying rates for each site, but, in all cases, it has had more to do with connecting with or redefining school structures

than it has with direct implementation of mathematics and science reform recommendations. We now have detailed pictures of these first steps in the progression toward sustaining change. As a result of direct experience, we have all adjusted our roles in making that change begin.

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