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Richard A. Walter raw18@psu.edu

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Large-Scale Teacher Enhancement Projects Focusing on Technology Education

M. David Burghardt
Hofstra University

Michael Hacker
Hofstra University

The co-authors have been co-Principal Investigators on two large-scale National Science Foundation-funded

teacher enhancement projects for the past eight years. One of the projects focused on middle and high schools and the second focused on the elementary school. The design of each was different, reflecting the differing natures of the educational programs at each level, but the importance of including technology education was common to both. In both projects, instructional strategies characteristic of technology education (which we define as the study of the human-made world), established links with mathematics and science education (MST) and were made explicit through teacher practice. There was an interconnected MST thrust to the instructional strategies that were employed and the activities that were created or refined.

The NYSTEN Project: 1993-1997

The New York State Technology Education Network (NYSTEN) Project was funded by the NSF to improve the quality of technology education in New York State. NYSTEN was designed to provide contemporary technological, pedagogical, and leadership enhancement to technology education teachers across the state. The pedagogical content focused on issues and strategies relative to access and equity, cooperative learning, authentic assessment, design and problem solving, and relationships among mathematics, science, and technology education. The technical content related to four areas: computer-aided drawing and design, computer control and interfacing, bio-related technology, and electronics. Leadership skills were enhanced in areas of community involvement and coalition building, and institutionalizing change.

Thirty-two lead mentors were initially selected; twenty-four were middle and high school technology teachers with expertise in one of the four technical content areas. These expert technology teachers represented different regions of the New York State, conforming to the eighteen Board of Cooperative Educational Services (BOCES) districts organized by the Department of Education, and six districts from New York City. The eight remaining lead mentors were mathematics and science educators linked to one of the same BOCES or New York City regions. They assisted their technology education colleagues in identifying mathematics and science concepts and skills embedded within the technology education activities and linked these concepts and skills to the New York State *MST Standards*. The mathematics connections included the explicit use of linear equations, solving simultaneous linear equations, binary numbers, geometry, and ratio and proportion. The science connections include sensory perception, respiratory system, microorganisms, Ohm's law, scientific inquiry, and human vision and perception.

The regional teams were conceptualized as having five members: two technology educators, one mathematics educator, one science educator, and one community partner. The teams, after enhancement, conducted four day-long regional content workshops and two half-day awareness workshops to other members of their schools and local communities, broadening the base of support for improvement and learning in technology education.

In the first year the lead mentors, after receiving two weeks of enhancement in the aforementioned pedagogical strategies, developed the *NYSTEN Implementation and Resource Guide (IRG)* (NYSTEN, 1996). The IRG had several purposes: (a) to provide technology education activities that use the latest pedagogical strategies, with particular emphasis on MST interconnections; and (b) to promote the use of design as an instructional strategy. In addition, there were materials developed for teams to use in making presentations to school boards, local civic organizations, and community groups, such as parent-teacher associations. In the last stages of the project, we developed mathematics and science activities that embraced design and MST interconnections. Activities included the design of a groundwater

pollution experiment, design and construction of a support beam and testing it to failure, design of a maze using probabilities for distribution of balls falling through the maze; and design and construction of a solar dehydrator, used to analyze dehydration and re-hydration of fruits and vegetables.

The project leadership was responsive to expressed needs of mentors, and willingly modified its initial project design to better achieve a number of project goals, including reaching our community partners with a fall meeting, meeting the needs of school districts by creating a third week of MST activities in July, providing linkages with other colleges so NYSTEN teams could act as resources to them, and supporting the New York State Education Department (NYSED) and its need to assist Schools Under Registration Review (SURR) in New York City. In response to a request from NYSED, a NYSTEN mentor volunteered to act as a consultant to MST teams in four SURR schools in the Bronx, helping them formulate plans and involving them with NYSTEN activities, so they could be implemented the following academic year. NYSED provided support in terms of supplies and the school district covered part of the NYSTEN mentors' salaries. As a result, NYSED hosted a conference for SURR schools at Pfizer in Manhattan, highlighting the success of the NYSTEN/NYSED approach. Another Bronx team mentor associated with Lehman College developed collaborative ties with the College's Institute for Literacy Studies, where several MST Summer Institute workshops were held. Lehman College submitted an Eisenhower Grant proposal for follow-on support using NYSTEN mentors and activities.

The one portion of the project that was somewhat disappointing was the community partner element. To be sure, there were some community partners and teams that jelled and where good synergy existed. In fact, one partner met with the New York Commissioner of Education and key members of the Board of Regents to advocate for mandatory high school technology education programs, and now serves as the chairperson of a national advisory council on another NSF-funded project. In general, the bonding between the partners and teams has not resulted in sustained working relationships to any appreciable degree, despite good intentions on all sides. It seems that the daily pressures of the work world distract partners from a continued focus on education. We may have also expected too much from the mentoring team in terms of arranging ongoing local meetings with one another and the community partner. We have looked for patterns, since the partners came from a variety of backgrounds: technical, parent advocacy, and business. The most successful teams included partners with backgrounds in either technology or education. At this point, we would not recommend that future programs include this community partner component unless the proposer can demonstrate previous successful experience, or the partner section becomes more dominant.

The final year of NYSTEN Project was devoted to rubric and benchmark development, with a focus on student assessment. The area of assessing student work (both products and processes) is complex. We have found that it is very difficult to achieve reliable assessment solely based on evaluation of design portfolios, independent of the artifact or observation of the student in the class, without explicit guidelines that in some ways limit teacher creativity. During the fall of the final year, several NYSTEN mentors conducted activities for which rubrics and benchmarks had been developed. They kept copies of the student portfolios for these activities. At the spring meeting of mentors, multiple copies of the student design portfolios were placed in folders and two-person teams assessed them. The results from the teams were tabulated and compared. The goal was to see if ratings were repeatable from team to team. They were not. For instance, for a mean score of 13.5 (not based on 100), the standard deviation could be as high as 6.6.

There were several reasons for this. One, the mentors had a difficult time assessing student work without seeing

the artifact. Two, even with explicit directions, the individual teachers conducting the activities added or deleted material from the activity based on their classroom situation; hence, the requirements for students varied. Three, the design portfolios were not conscientiously completed. Four, some of the teachers mentioned material developed by the class as a whole that was not recorded in the individual portfolios.

It seems that for multi-teacher assessment of activities not observed, very specific guidelines-perhaps even step-by-step directions-need to be provided. This conflicts with the open-ended aspects of the design process. More research will be needed in this area.

The NYSTEN model worked very effectively at creating a statewide network of teachers who are agents of change across the state. It has been effective at bringing together teachers from different fields and creating common understandings and respect for one another. Of particular note was the heartfelt advocacy mentors expressed for their colleagues' programs in mathematics, science, and technology education. Many of the NYSTEN mentors have become leaders in their fields over the ensuing years. One is the NYSED mathematics state supervisor. Many became school administrators. Others became university faculty members and still others became professional association leaders, activists for educational reform, and directors of other projects.

There has been a change in how teachers view themselves; there are not separate disciplinary views to the exclusion of others, but disciplinary views with the inclusion of others. There was a significant change in the attitude of technology teachers, often viewed as second-class citizens in the school hierarchy, to being educational leaders on the forefront of change, as the MST Standards became established in New York State.

The NYSTEN project received a significant cost share from industrial partners. The outcome of one such cost share contribution from Lego Dacta was the development by a NYSTEN team of a product commercialized by Lego, the *Intelligent House*, based on the NYSTEN activity *Smart House*.

Another feature of the project was the creation of a newsletter. Participants were encouraged to submit articles about their team, the workshops they ran, and changes occurring in their schools. This was not part of the original plan, but was one of the suggestions from the mentors. Since the project coordinator had familiarity with producing newsletters, it proved to be a very valuable resource for keeping mentors connected throughout the year.

A challenge in multi-year teacher enhancement projects is sustaining through the academic year the momentum and enthusiasm developed in summer workshops. Having teams of teachers is certainly important; they provide mutual reinforcement of ideas and encouragement to change teaching methodologies. Even when teams bonded, they very much appreciated the continuing, formal opportunities to meet the colleagues with whom they worked during the summer. Fall meetings reinforced the summer's work and provided the motivation to carry out the activities, often workshops that teachers planned to accomplish. The spring meetings served as springboards for the forthcoming summer and were a forum for formative feedback to the project, as well as an opportunity to showcase group accomplishments.

Teacher enhancement projects are more than a way to provide cutting-edge educational activities for teachers. To be sure, this is very important-essential-but perhaps equally important are activities that create a spirit of camaraderie, a

bonding of the teachers as a group. For multi-week projects, we discovered that evening activities were necessary unless the project involved only commuting teachers. The daily routine for workshops was often 9 a.m. to noon and then 1 p.m. to 4 p.m. The participants were tired after six hours in the classroom and need a break, but not a break until the next morning. A mix of intellectual activities, including presentations by experts in fields related to what they were learning and more time for learning sophisticated technologies, were popular evening events. In addition, arranging trips to ball games, evening barbeques, and weekend trips to places of interest were well received. The learning never stopped, of course, as much of the conversation centered on the workshops they were immersed in.

Related to this, we found that amenities matter. Clean and comfortable housing is important. In some instances we chose not to use dormitory housing, as it was too primitive. If the college or university is not set up for housing adults, then using local motels is a wise thing to do. Mixing undergraduate students with teachers is not wise, because their lifestyles are usually too different. A generous food plan is also a big plus. When teachers are away from home, generous provisions for living support make them feel appreciated and welcome. To do otherwise is false economy.

In the summer of 1996, 60 teachers in four-person teams from 15 states other than New York attended a national dissemination workshop run by the lead mentors. Each team included a member from that state's department of education. Participant response was very enthusiastic, as indicated by the following comments:

> The workshop seemed great for tech teachers and seemed to help teachers from other disciplines realize the connection between their subjects and technology education.
>
> The program should be extended to elementary school teachers so that kids can have an early start in MST.
>
> I think it will be good to make use of the activities. We can show those videos to other teachers in our school and also have them as reference for the future. It will be good to have more lessons/activities that we can develop. What about shorter lessons that could be finished in a week? I would like to have access to a site on the Internet from which I can download lessons/activities.
>
> This was quite an eye-opener for me-there are things I can do to help the technology department or bring in to my room. The mentors did a super job of blending the curriculums-thus modeling for me how I, too, could do this.
>
> I wish more math/science/tech teachers could become involved and experience this seminar. Perhaps more important to systemic change will be the inclusion of administrators, counselors, supervisors who often do not have any idea what technology is all about.

The MSTe Project: 1997-2002

The five-year *MSTe Project: Integrating Mathematics, Science, and Technology in the Elementary Schools* is a collaborative effort involving The New York State Education Department (with the active support of the Commissioner of Education), Hofstra University, The State University of New York at Stony Brook, Brookhaven National Laboratory, and 20 New York State school districts and BOCES. The project draws on the strengths and commitments

of respected institutions, proven project managers, research scientists and engineers, expert educators, and supportive local school administrators.

The MSTe Project was designed to enhance pedagogical abilities, mathematics, science, and technology (MST) content knowledge, and leadership expertise of 20 three-person MSTe leadership teams in New York as teachers began to address the national and New York State MST Learning Standards. In year two, the project evaluator noted in her annual report that 98% of the participating teachers understood MST assessment, 98% felt they had gained leadership and content knowledge skills, and 94% acknowledged enhanced pedagogical skills. The teams conducted workshops to support 1,200 second-wave elementary school teachers. The participating educators were primarily from New York City and Long Island and reflect the diversity of the State. This project complemented the statewide and urban systemic initiatives and assisted those projects in expanding both their emphasis on inquiry and design and their reach across the state.

Nearly all MSTe leadership teams included two experienced elementary school teachers, one from grades K-3 and one from grades 4-6, and one MST content specialist. Project staff, team school administrators, and senior-level BOCES staff development experts who are members of the New York Staff and Curriculum Development Network all supported the teams.

A great strength of MSTe is the full commitment of all participating LEAs. Memoranda of Agreement (MOA) have been received from Superintendents of Schools pledging to recruit and support teachers, pay honoraria and in-service salary credit, provide exemplary teaching materials, and sustain Project activities.

During years one and two, MSTe leadership teams participated in four weeks of enhancement each summer. The enhancement used nationally validated exemplary curriculum materials, such as Science and Technology for Children and AIMS, which focus on MST content, pedagogy, and leadership development. In addition, the workshops provided a supportive and nurturing instructional environment and gave direct experience with activities that will be implemented in the classroom.

Participants received enhancement at three institutions with unique and beneficial resources. At Hofstra University, mathematics and science elementary education faculty at the School of Education created an MST teacher education program. Hofstra's Center for Technology Education provides outreach to mathematics, science, and technology teachers, hosts competitive MST events for students, and provides insights from the NYSTEN Project. SUNY-Stony Brook has a Technology and Society program with a longstanding tradition of K-12 MST teacher enhancement. A portion of the workshops took place at a clinical practice site in the SUNY-Stony Brook campus school lab. Brookhaven National Laboratory, which has an ongoing teacher education program, recently conducted the NSF-funded elementary MST *National Teacher Enhancement Project* (NTEP), and organizes statewide MST conferences for teachers and teacher-educators. At Brookhaven, teachers worked with scientists and engineers to see MST integrated in practice.

Summer workshops were supplemented by a peer-coaching component involving the teachers and MST content specialists. Follow-up classroom visitations during the academic year were made by the co-PI's. In addition, regular team reflection meetings were held during each academic year. The spring and fall meetings of the teacher/mentors

were designed to include administrators so that they were prepared to support teachers in creating an environment conducive to exemplary MST teaching and learning. The conceptual model underpinning the integration and connection of MST is derived from the approach used in the New York MST Standards. This approach emphasizes problem solving, which integrates mathematical analysis, scientific inquiry, and technological design, and revisits themes that are common to the three disciplines in a variety of contexts familiar to children.

An *Implementation and Resource Guide (IRG)* (MSTe, 2001) was developed by and for the MSTe leadership teams as a planning and decision-making tool. The *IRG* has sections on workshop planning, use of materials in an MST context, related research, annotated MST activities, and links between Project curriculum materials and the New York MST Learning Standards, the national standards, and the 2061 Benchmarks. Additionally, a videotape of effective MSTe leaders was produced with support of NYSED and a public television station. The video was used in second-wave teacher enhancement sessions and to heighten public awareness.

During the second summer workshop, MSTe teams assessed student work for evidence of understanding of mathematics, science, and technology concepts against criteria the teachers established in the form of scoring rubrics. The design portfolio was refined after the first year and provided to teachers in hardcopy and on disk. In addition, teachers developed and tried out MST activities they refined or created with guidance from the co-Principal Investigators. The project participants discussed "MSTing" existing curriculum. At the end of the second academic year, prior to conducting the regional summer workshops, the MSTe teams and their administrators planned and held awareness sessions to recruit teams of second-wave teachers, and to inform parents and community members about the Project goals and progress.

In years three and four, the 20 MSTe leadership teams conducted two-week summer enhancement programs for teams of elementary school teachers in their regions. The regional workshops were modeled after the two MSTe summer workshops and made use of the *IRG* (MSTe, 2001). Like the MSTe leadership teams, the second-wave teachers used exemplary materials and the *IRG*, reflected on their own learning, and assessed student work for evidence of MST learning. A total of 100 hours of enhancement was provided to second-wave teachers through summer workshops and ongoing academic year meetings.

In year five, a conference was convened for MSTe leadership teams and school administrators to collaboratively plan how gains made at the local level can be sustained once the Project concludes. As an outgrowth of this meeting, plans were formulated to create an MST statewide professional association and follow-up conferences. Ten mini-grants were distributed to teams on a competitive basis after they submitted formal proposals in response to a project-generated RFP. An additional 400 teachers are being provided with 100 hours of staff development opportunities as a result, and participating districts have cost-shared over $300,000.

A three-week Statewide Leadership and Dissemination Workshop occurred during the summer with teams, modeled after the MSTe teams, from 15 school districts across New York State attending. The teams developed plans to implement MST activities within their own schools, and with BOCES support, conducted local awareness-level workshops for teachers in their regions.

Reflections on the MSTe Project

As the MSTe project was nearing completion, project staff asked each of the leadership teams to reflect both on their experiences and on the impact of the project on their districts. The responses provide evidence of the kinds of challenges faced, and the successes achieved, by the MSTe project. This section provides information about the leadership teams' perspectives on the project; their perceptions of its impact; the likelihood that changes brought about by the project will become institutionalized; and lessons learned that can be used to inform future projects.

When asked how they personally had experienced the MSTe project, respondents talked about both the difficulties and the rewards of the process. The challenges inherent in the project were clearly worth the effort, according to the responding leadership teams. They talked about how they had developed their leadership skills, the impact on MST teaching and learning in their own classrooms and in the districts overall, and how the project had increased the sense of collegiality and professionalism among teachers in their districts.

> Working on the MSTe project was rewarding, challenging, and at times mind-boggling.

> Learning as we went along, the challenge of overcoming difficult design projects and the frustration of not having answers helped us empathize with how our students feel.

Leadership teams had a great deal of praise for the project staff and for the quality of the professional development they received from them, noting that they felt "honored to have been part of this project." They talked about the excellent modeling provided by project staff, both in the intensive summer training and in the on-going follow up support; and the "firm commitment" on the part of the project leaders "to making learning better for *all* students." Some noted specific skills they had gained, while others attested to their overall growth as mathematics/science/technology educators. Comments included:

> I find myself listening more to the suggestions of my team. I have also learned how to disagree tactfully when necessary and sort of compromise when it is necessary.

> As a result of participating in teacher enhancement workshops, peer coaching, and studying with scientists and engineers over a two-year period, I became more aware and eager to continue my training. No longer was 1 hesitant about the unknown, but curious and energetic.

> I learned more in the two months of [leadership] training than I had in most of my college career, including graduate work.

Respondents also talked about how their participation in the MSTe project had led to their being recognized as leaders in the field. Seven of the ten responding teams noted that one or more of their members had served on curriculum or textbook selection committees, and 6 of the 10 noted they had been asked to provide professional development to other teachers beyond their MSTe project responsibilities.

While a couple of respondents indicated that they had already been using the MSTe project approaches in their teaching, other leadership team members provided examples of how participation in the project had affected their teaching. One admitted, for example, to now aiming for "fewer subjects in greater depth" rather than attempting to

"cover" the curriculum. Noting that the project "broadened my perspective and gave me concrete activities that I could bring back to my class," another leadership team member talked about using "more hands-on projects, … more cooperative grouping, more interdisciplinary themes," among other changes.

> I have learned how to make my lessons more integrative and basically more meaningful through hands-on experiences.

> The project has increased my awareness of connecting MST to a wide area of academic interdisciplinary teaching …. The project has also given me the ability and confidence to expand on different strategies and learning modalities.

Every responding leadership team was able to provide examples of the impact of the MSTe project on the teachers with whom they worked, typically referred to as "second wave" teachers. The most frequently cited effect was the use of M/S/T as an organizer for instruction, especially in integrating those subjects, but sometimes also in weaving in other areas such as social studies and language arts.

> After participation in these workshops, the teachers had a more complete understanding that their grade level science curriculum is not taught in isolation, but integrated with math and technology.

> The teachers trained in the MSTe philosophy routinely integrate science, math, and technology into their content area lessons, exposing students to real-life problems.

> When I was facilitating the [second] waves, many of the teachers came in with certain preconceived notions. I can honestly say that after 100 hours and the follow-ups at each of the schools during the year, each one of them had changed. I was able to show how easy and successful MSTe was to integrate and to model for students.

> MSTe has made a difference in the way I approach many of my lessons. When planning enrichment lessons I often consider how I can "MST" the curriculum or a special project. Previous to my MST training I struggled with how to incorporate math and science into a language arts lesson. It is now rare if math and science are not a component of many of my projects.

> At our school, we have formed an MST committee that meets monthly to discuss various ideas and projects. This is our time to share things that have worked well for us, things we want to change in the future and help to formulate new ideas.

In addition to talking about the use of MST as an organizer for the content of lessons, a number of respondents provided examples of greater use of "reform" pedagogy. For instance, several teams talked about an increased use of hands-on activities, noting that second wave teachers were including "contemporary pedagogical methods" to a much greater extent, "including cooperative learning, learner-centered constructivist teaching, metacognition, and authentic assessment of student learning."

The ultimate goal of any teacher enhancement project is improved student outcomes, and the MSTe project is no exception. In New York State fourth grade students undergo standardized testing in mathematics and in science, as well as language arts. There were eight fourth-grade teachers in the leadership team of the MSTe project. In 1999, the eight MSTe fourth grade leadership team teachers reported their class scores on the New York State Grade Four Mathematics Assessment to the project evaluator. In seven of eight cases, the MSTe teacher's class outperformed the school and district average. For the same year, these same leadership teachers reported their class scores on the New York State Grade Four Elementary School Science Program Evaluation Test (ESPET). In seven of the eight cases, the MSTe teacher's class outperformed the school and district average. In addition, leadership teams were asked to provide any evidence they might have that the project had impacted students. Most of the responding teams were able to do so, citing examples of more positive student attitudes towards those subjects and increased student understanding of mathematics, science, and technology. In one school district, for example:

> Elementary students have been achieving significantly above the state assessment averages on the fourth grade math test and the ESPET. Since 60% of the second grade teachers, 100% of the third grade teachers, and 80% of the fourth grade teachers have completed MSTe training, we attribute the improvement in scores in large part to this philosophy.

Several teams cited examples where the MSTe approach was beneficial to diverse learners. For example:

> I was able to see how students from high to low functioning academics were able to understand and make connections to other things.

> One major impact that I have seen is that children with learning disabilities seem to be much more engaged in this type of inquiry learning and they are able to succeed where they have failed in the past. When we did a unit on frogs in a second grade classroom we noticed that children who seemed unable to write information were able to keep journals about their frogs' development, [including] illustrations that were labeled.

A number of teams mentioned that parents were becoming more involved in their students' MST education, and had noticed a change in their children's attitudes and understanding. For example, a leadership team member in an inner city school district reported that she now has "parents who are eager to take their children to the public library because the children are investigating the sciences."

Most of the responding leadership teams provided evidence of extensive school and/or district support for the MSTe project. For example:

> Our district was completely committed to the MSTe philosophy and has provided us with the necessary tools to support teachers who are working toward this interdisciplinary, inquiry approach.

> Overall my district is doing a great job at implementing MSTe practices. My school is also very supportive. [The principal] has purchased Math, Science, Reading materials which lend themselves to MSTe practices. She is always willing to allocate time for MSTe professional development and also

funded my MSTe after-school program.

Leadership teams were asked about the "lasting impact" of the MSTe project, and the likelihood that the reforms would become institutionalized. Although none of the responding teams indicated that the MSTe project activities in their districts would be implemented at the same level once the NSF funding had ended, quite a few cited evidence that various aspects of the project are likely to continue. In several cases, the leadership teams reported that inclusion of MSTe-trained teachers on materials adoption committees led to selection of materials that are aligned with the MSTe vision. For example:

> It is clear that even skeptics are realizing the necessity of the integration of math, science, and technology into all curriculum areas as well as providing problem solving within a real-world context. A new math program is being researched with the emphasis on manipulatives and problem solving at the elementary level. Many of the committee members have participated in the MSTe Project.

> As [the district] begins the process of revising our elementary science program to reflect the new Elementary Core Curriculum, we are doing it under the MSTe umbrella. Technology and mathematics will be incorporated into the science instruction. Design portfolios will be an important part of the revised curriculum.

Some teachers reported that school family nights had improved parents' understanding of MST inquiry, and their ability to ask questions to help their children move forward in their thinking.

> In addition to the classroom work we have had a family night for our first and second graders and their parents. This has been very successful for the past three years. During the evening event our students and their parents move about from one station to another exploring activities that exemplify inquiry in math, science, and technology. The response for this night is wonderful. We typically have a total of over three hundred participants. Teachers help with the evening and we have noticed how much better parents have gotten at asking the questions instead of helping the child.

Conclusions

After eight years of running teacher enhancement projects we have gained some perspective on what has worked for us. Key overall strategies include:

- Listen and adapt to teacher/mentor needs. This is perhaps the most important piece of advice. The teacher/mentors should be treated as colleagues and professionals whose thoughts and advice are valued. This philosophy enfranchises them and helps make them willing advocates of change.
- Thoughtfully plan summer enhancement time. Teachers have many demands on their time in the summer even when they volunteer to be part of enhancement projects. It is difficult to attract teachers for dormitory-based projects and even more difficult when more than three consecutive weeks are planned in the summer. Similarly, even teachers who commute home daily find that more than four consecutive weeks in the summer is trying. When teachers are dormitory- or motel-based, provide evening enhancement and social activities. This is less

necessary when most teachers commute and want to go home in the evening. Ample food and pleasant housing are very important and create goodwill. Experience indicates that spartan dormitory living creates a negative attitude.

- Develop meetings throughout the year. Once the bonding experience of a summer workshop occurs, teacher/mentors want to meet again. Plan to have a meeting in the fall and spring. The fall meeting typically will serve as a boost to encourage teachers to implement changes, and often can include administrators to ensure their support. The spring meeting serves as a sharing time, a time for the project to make mid-year corrections based on formative feedback, and to plan/revise the next summer's plans.
- Create a newsletter for the project. Modest newsletters formed from articles teacher/mentors write are comparatively easy to accomplish. They are used to keep teachers connected and to influence administrators and other stakeholders. More sophisticated newsletters can have a wider circulation based that includes parents, local businesses, and school board members, but they are more demanding to produce. The newsletter should be produced in hard copy, because teachers like to have something to hold onto. Our experience with listserves and electronic communication has had mixed results, particularly the listserves. They should not be relied on as the only means of communication.
- Formalize the school district's commitment. Implementation of teacher enhancement pedagogies and support material has occurred most successfully in those districts where the administration is very supportive. Memoranda of agreements (MOA) between districts and project staff will detail what the project will provide and how the districts will support the teachers. Even with MOA's, shifts in administrative priorities can reduce the effectiveness of the project's implementation in the district.
- Work with others. Collaboration among institutions of higher education, state agencies, school districts, and others creates strong programs. Teacher/mentors and administrators find the breadth of support attractive. Local industry/business members can be particularly useful on advisory boards.

Specific Implications for Technology Education

We have also learned how important technology education is to the overall success of such projects. It is inherently interdisciplinary and constructivist in nature, placing students at the heart of their learning. We found that several strategies are beneficial to heighten technology education effectiveness:

- Use design challenges as a fundamental instructional strategy. This approach starts the integration of learning. Students must research, document, and develop solutions that embrace their creativity and link many areas of instruction.
- Use design portfolios at the elementary and middle school levels. The portfolio guides and documents information and student thoughts as they seek solutions to design challenges. At the high school level, once students have used a design portfolio, the use of design reports has an additional advantage of language arts reinforcement.
- Develop and disseminate MST activities. Enhancement projects are strengthened by collaboration, and so are technology education activities. Make explicit the mathematics and science connections. The designs students create and the depths of their understandings are enhanced by these connections. This also acts to bring technology education into the academic mainstream. These activities can be part of an implementation and resource guide.

- Link technology teachers with teachers from mathematics and science in designing enhancement projects. We have consistently witnessed positive, dramatic changes in teacher attitudes towards one another as they work together on MST activities. This carries over to schools and districts and is very important for creating sustainable change.

References

MSTe Project: Integrating Mathematics, Science, and Technology in the Elementary Schools. (2001). *Implementation and Resource Guide*. Stony Brook, NY: SUNY-Stony Brook.

New York State Technology Education Network. (1996). *NYSTEN Implementation and Resource Guide*. Hempstead, NY: Hofstra University.

Burghardt (m.d.burghardt@hofstra.edu) is Professor of Engineering and Chair of the Department of Computer Science at Hofstra University in Hempstead, NY. Hacker (mhacker@nycap.rr.com) is Co-director of the Center for Technological Literacy at Hofstra University.

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