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The Eastman Scholar Mathletes: A Collaborative Partnership

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A portion of this chapter is based on a long-term science education professional development training model employed at East Tennessee State University, which has been previously published in other sources.

Introduction

Professional development has been of central importance throughout the mathematics education reforms in our educational history. Recognizing that math teachers represent the major link between the curriculum and student learning, expert practitioners, researchers, and policy makers emphasize professional development as an essential mechanism for deepening teachers' content knowledge and developing their teaching practices. Oftentimes, professional development has focused on the content knowledge of teachers. We have designed an expanded view of professional development that incorporates a leadership component in which math teachers become leaders in both their schools and school districts in order to advance reform efforts and impact student learning (Guskey, 2003; National Staff Development Council, 2001; Sparks, 2004). This role of professional development promotes job-embedded, sustained opportunities for professional growth and systemic change (Loucks-Horsley, Love, Stiles, Mundry, & Henson, 2003).

In this paper, we present the story and lessons learned from a professional development partnership between a Fortune 500 company, a regional state university, and several county and city school districts in rural Appalachia. While the story of the partnership is interesting, in many ways the project we call the *Eastman Scholar Mathletes* (ESM) *Project* grew far beyond its initial planning. In this chapter, we seek to inform the broader community about what is possible in partnerships such as this one, as well as those things that were planned and unplanned, and how to leverage the momentum that such a partnership generates. In the following sections, we provide details on the partners involved, the original nature of the program, outcome measures for evaluating the program, the impact on the region, issues such as sustainability, stumbling blocks encountered along the way as well as new developments. We hope you not only enjoy reading this, but that in reading you can better plan your future partnerships or improve existing ones.

The Partners

East Tennessee State University (ETSU) is a large, regional university serving the Appalachian region as well as the state of Tennessee. ETSU is home to the Center of Excellence in Mathematics and Science Education (CEMSE) that facilitates outreach and professional development programs in the region and throughout the state. One of the roles of CEMSE is to build partnerships and strengthen the mathematics and science education capacity of the local districts.

Kingsport, Tennessee is home to Eastman Chemical Company (ECC), a Fortune 500 company that employs almost 10,000 employees. As a part of the Appalachian region, Eastman Chemical seeks to improve the community by actively engaging in educational outreach. Among their many initiatives, the Eastman Scholar Mathletes project is an outgrowth of a collaborative partnership with CEMSE. Eastman's financial investment in the program, over multiple years, is a testament of their commitment to improve mathematics education in the region's schools. In 2006, Eastman Chemical Company realized that over 50% of their engineering and operator work force was going to retire within the next decade. Moreover, analysis of state test scores in grades K-12 and other scores (e.g., T-CAP, Gateway) revealed that many students would likely experience difficulty in passing the math component of Eastman's application exam. ECC was interested in sustaining future employment needs for the company within the local region. Consequently, in the Spring of 2007, ECC and ETSU partnered together to develop a two-week summer workshop program to strengthen both the math content and teaching skills of area teachers of grades 3-8. But much, much more emerged from this on-going program.

Among the local districts, the initial partnership began with two city school districts and three county school districts. As we discuss later, two districts were eventually added as part of the growing process of the program. All of these districts are located in rural Appalachia, and while there are four city school districts, these cities range in population from Rogersville, approximately 4500 people to Johnson City, approximately 62,000 people. Using ETSU as a central location, each summer the selected teachers would attend a six hour workshop daily for ten days over two weeks.

Nature of the Project

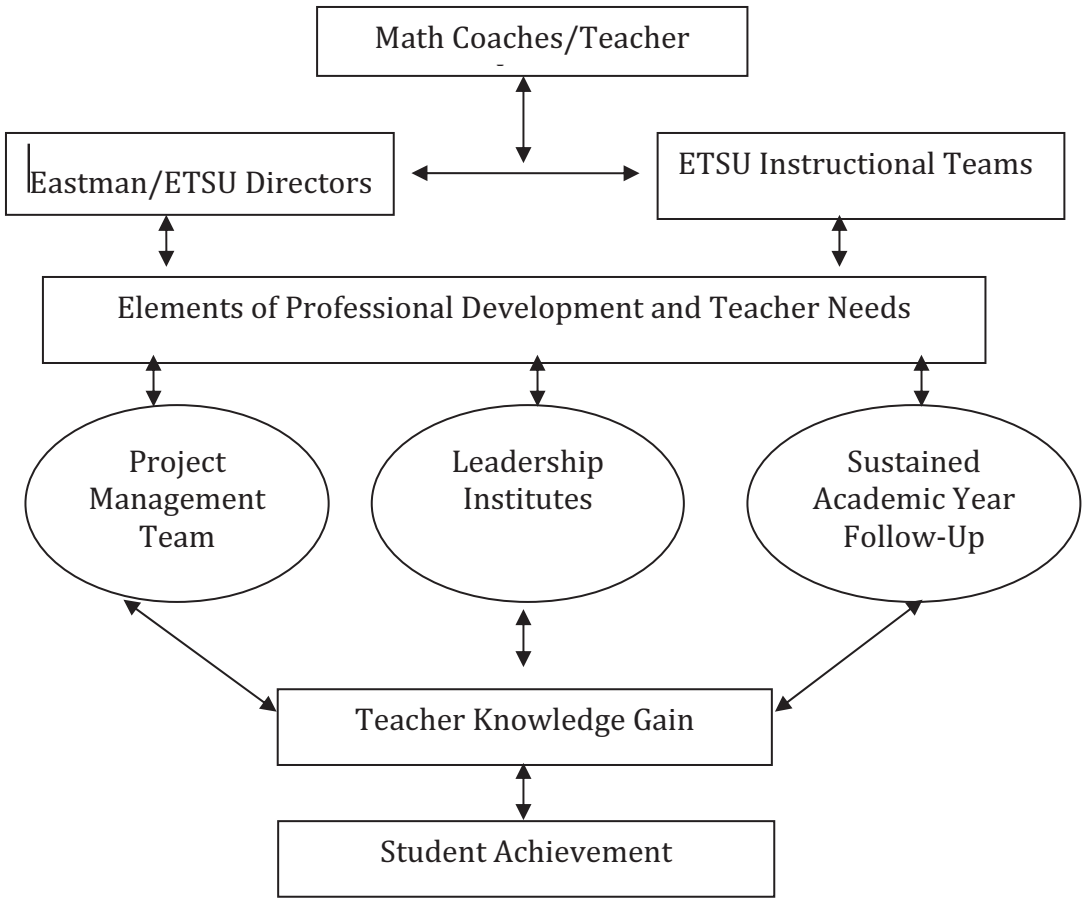
The Eastman Scholars Mathlete Project provides an example of one way in which an ongoing, sustained professional development support system can assist elementary and middle school math teachers in improving their knowledge of math content and pedagogy and engage their students in meaningful math learning experiences.

The model (Figure 1) emerging from this four-year partnership with ECC possesses the following properties. First, it offers sustained professional development support and teacher training throughout the academic year. Second, it requires the simultaneous development of instructional skills and content expertise. Third, it has required a full time math coach in each of the six participating school districts.

Figure 1: ECC and ETSU professional development model, adapted from Rhoton and Wojnowski (2006).

Eastman Chemical Company's Scholars Mathletes Project

Professional Development Model



Since the inception of the program, 240 teachers in grades 3-9 have participated and more than 50 principals have been directly or indirectly involved in the activities of the model. The ETSU model captures many of the principles of effective professional development by ensuring that math teachers acquire a deep understanding of math content and pedagogy (Rhoton & Bowers, 2001). Researchers and expert practitioners agree that content knowledge can have a positive influence on student achievement, especially in elementary and middle school math (Blair 2000; Whitehurst, 2002).

ECC made a five-year commitment to East Tennessee State University to sponsor a two-week summer workshop for area grades 3-8 teachers over four summers (2007 – 2010). Each participant has received 3 graduate credits and a $700 stipend upon completion of the workshop, with tuition and fees paid by ECC. There were three instructional levels covering grades 3-4, 5-6, and 7-8 grade-level teachers (eventually grade 9 was incorporated into the 7-8 group). The overall goals were to incorporate pedagogy, math content, and best teaching practices that matched Tennessee State Curriculum standards. Teachers were engaged in hands-on activities and presentations of

their work in the daily sessions. This allowed the teachers to experience learning in a way that we would like to see them teaching their own students.

The math specialists from the participating city and county schools attended the daily sessions enabling them to follow up with their teachers on the content and pedagogy learned from the workshops.

Institutes focus on both math content and inquiry in teaching and learning. Participants engage in a variety of investigations in the following areas: mathematical processes, numbers and operations, algebra, geometry and measurement, and data analysis, probability and statistics, with topics for investigations driven by the participants, student data, and local and state math standards. Investigations and institute activities are presented in the context of how the teacher participants can implement them effectively in their own classrooms.

In addition to learning math content, participants explore questions and ideas about their students' learning, their teaching, and their curricular approaches. These conversations prepare the participants for examining meaningful ways to connect their students' understanding with accepted practices of teaching and learning, thereby providing for a seamless integration of content and mathematical ideas with knowledge of student learning and pedagogical practices.

After participants return to their schools to implement the new teaching strategies, math coaches and university math faculty provide ongoing support for them by visiting them in their schools during the academic year. During these visits, math coaches and university faculty gather information from teachers and principals as they implement the professional development model as well as support teachers in their classroom environment. Math coaches work with their peers by leading weekly and monthly math in-service training sessions, observing peer teachers, teaching model math lessons, and assisting math teachers in analyzing and selecting instructional materials for their classrooms. The work of the math coaches throughout the school year occurs within their respective districts and is independent of the summer program.

Outcome Measures

Curriculum and Evaluation Standards for School Mathematics (National Council of Teachers of Mathematics, 1989) and *Professional Standards for Teaching Mathematics* (NCTM, 1991) are two documents that outlined an initial design for the reform of mathematics teaching and learning. A subsequent document, *Principles and Standards for School Mathematics* (NCTM, 2000) initiated a design that was an attempt to realize the initial design. Furthermore, *Adding It Up* (2001, p. 116), outlined five attributes associated with the concept of student proficiency: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. These approaches are consistent with the ECC/ETSU Partnership Model, which considers students as active constructors, rather than passive receivers, of knowledge. Accordingly, students who bring their own view of the world into the classroom are encouraged to be engaged in the learning process. An important role of the teacher in this process is to create learning environments that allow students to engage in problem solving and higher-order thinking.

Content gains in teacher knowledge

The ETSU faculty involved in instructing the teachers provided the participants with pre-tests and post-tests of content knowledge each summer. While this is not a report of all the data we collected, here we present the content gains from two different sets of participants.

As Table 1 shows for the summer 2009 participants, the average score on the pretest was about 24 points, or 69%. The maximum score was 33 and the minimum score was 12. Following the two-week program, the posttest average was about 29 points, or 81%. The maximum score on the post-test was 35 and the minimum was 21. Out of the 16 teachers, 14 increased in score, one stayed constant, and one decreased. We have very similar results for all levels of our teachers over the last three years.

Table 1. Content gains for summer 2009 participants in the 7th and 8th grade section

	Pre-Test		Post-Test
average score	24.8125		29.125
average %	0.689236111		0.809027778
t-test	4.88	df=15	
	0.000200058	$p<.001$	

These content gains have been important measures of documentation, not only for the instructors of the professional development, but also as a basis to continue funding and expand the project.

Surveys

We made use of surveys to evaluate the value of the program and how the summer experience translated into instructional changes in the classroom. Some surveys were given during the 2-week summer course, while other surveys were conducted throughout the school year with the teachers, math coaches, and other school administrators.

In our previous work in professional development, we experienced working with teachers who were not there by choice. We found out through the participant reflections that we also had teachers who did not really want to participate. For example, one teacher said,

> I was not excited about this at all. I begrudgingly signed up for it so that our school would not miss out on the $700.00 and no other teacher at our school could attend. I grumbled constantly from the moment I signed up until July 7. (ESM Mathlete, summer 2008)

This illustrates the conditions under which some teachers encounter their professional development. However, it provided insight into what sort of issues teachers in this area face, as well as the level of sacrifice these teachers are willing to make for their schools and their students. Fortunately, this teacher went on to say, “I am so glad I took this class. The activities that we have done have been beneficial to me as both a math student and a math teacher.” We find it extremely fulfilling to have such participants in our classes. Seeing a teacher recover from what they perceived as a less-

than-desirable situation is always satisfying. Ultimately this teacher had a good start to the coming school year and the students of this teacher benefited from more than the supplies purchased. She has continued her participation in the local mathematics education community by actively participating in the meetings of the Upper East Tennessee Council of Teachers of Mathematics (UETCTM), our local NCTM affiliate.

We surveyed the principals to determine if there were noticeable changes in the classroom and school culture. We received an overwhelming response for the program, and while the surveys incorporated a Likert-based scale of several questions, the spontaneous comments written in spoke volumes. Some principals considered the effects on their building's progress in Adequate Yearly Progress (AYP) as specified by the No Child Left Behind Act. Other principals looked at a teacher's value-added scores, a statistical measure of student scores that predicts how much a student improves each year. For example, one principal wrote, "Both of my Mathletes' classes are energetic and the kids love math. The students are learning new strategies for problem-solving and are learning the 'why' involved with math." Another said, "We were a 'targeted' school because we did not make AYP in Math last year. This year we made AYP in Math and are no longer 'targeted'." A third wrote in, "Before [the ESM Project] the participant had negative value-added math scores. [After the ESM Project] she had the highest value-added in school and beat most of the [teachers in the] system." Several other principals from other districts also reported their Mathlete teachers as having the "highest value-added math scores of all our teachers."

These statements verifying the substantial changes made in instruction and morale led to increasing numbers of teachers wishing to be involved in the project, as well as neighboring districts wanting to be involved. However, there was still a need to document what the funding agency considered a more objective measurement: student scores.

Student scores

Throughout the first three years, student scores were initially a time-consuming process to gather. Because of the way the data were collected by districts and reported to the state, each student in a Mathlete teachers' classes had to be found within a range of different teachers for the previous year's scores. All of this had to be done by hand, and with over 70 Mathlete teachers, some having close to 100 students each, the task was almost insurmountable. A simpler measure was to use a teacher's value-added score, but initially these scores were reported to only the principal and the individual teacher.

However, a recent change in legislation as part of Tennessee's bid in the Race to the Top funding changed the way teacher and student scores would be available. These new changes have made it possible to easily collect this data and present it in an anonymous fashion to show the effects of our work. These scores may or may not be sufficient to show the sort of outcomes needed to continue the program. There are also questions about how valid the scores are in determining the effectiveness of a professional development project since the test they are based on is only one measure of a student's learning.

Impact of the Professional Development Model

When math coaches and university faculty make their school site visits during the academic year, they can accomplish two other objectives. They can gather information from teachers and principals and provide support to participants as they implement the

content and pedagogy they learned in the institute. During the visits, model lessons are presented. Visits, however, do not provide the continuous networking inherent in the professional development model. The project model gives participants an opportunity to develop a networking force for improving elementary and middle school mathematics teaching and learning in the participants' schools.

The model allows for several kinds of communication and networking between and among teacher participants, both within the classroom and across the math program. Teacher participants play the role of sensitive facilitators to establish a climate in which team members build mutual trust and share what they have done in their classrooms. The professional development model allows for the teachers to network in the following ways:

- Project participants meet throughout the academic year to discuss and share information, classroom feedback, and discuss content.
- Teacher participants lead professional development sessions for their colleagues during the school year. Some teachers work within their district, some present sessions at the Upper East Tennessee Council of Teachers of Mathematics (UETCTM) meetings, and some return the following summer to share with the following year Mathlete teachers.
- Principals in participating schools meet with math faculty in their schools to provide information and resources concerning math teaching and learning and to reduce barriers that impede effective math teaching.

Major rewards of the program have been the personal renewal of elementary and middle school math teachers' expertise in math content and pedagogical skills, increased focus on active student participation and student learning, frequent teacher-teacher and teacher-student interaction, and implementation of lessons that provide an accurate portrayal of disciplinary knowledge, nature, and structure.

An important outcome of this model has been continuous and ongoing professional development opportunities for participating school districts to track and document change systematically. These data revealed the following outcomes for participating schools:

- Networking of stakeholders (teachers, math coaches, curriculum supervisors, principals, and university staff) who are responsible for student achievement in the training process.
- Sharing of support materials and resources in support of the math program.
- Using student data to inform professional development decisions. Because each district has a math coach, results from state and district tests are used to target weak areas in student mathematical content.

Local school support for school math has increased throughout the duration of the project. One particular aspect of this is increased participation in the local NCTM affiliate.

Leadership through the local NCTM affiliate

The ESM Project created leaders in areas outside the school districts. One place this was obvious was with the local NCTM affiliate, the UETCTM. In the years leading

up to the ESM Project, the leadership roles of this group rested upon a few individuals. As a part of the ESM Project, participants were provided a one-year membership in the organization in hopes of sustaining the local educational community. What was not planned was the explosion of participation that would result from these teachers. As of the 2009-10 school year, all the leadership roles of the UETCTM are filled by former Mathletes. With the strong ties and connections between the local districts, the six annual meetings of the UETCTM rotate between host school buildings in each of the districts. Furthermore, the UETCTM Newsletter now contains several essays written by Mathletes allowing for information beyond dates and times of the summer institute.

Intra-district developments

If we had been planning the networking that only occurred spontaneously, we would have included goals such as breaking down the culture of isolation. Through their participation in the ESM Project, the teachers had removed thoughts of weakness and inadequacy in terms of the teaching of mathematics. One of the structures that facilitated this was the requirement of a district math coach. One principal commented,

> This is one of the first programs provided to our teachers that provides ongoing networking and follow-ups with our math specialists. Our math teachers are provided with important teaching strategies for math that they did not receive in college. It has changed teaching styles and teaching attitudes. (principal write-in comment on survey)

Comments from teachers indicated a new level of networking among teachers. These comments ranged from within building collaborations to within district collaborations. For example, one teacher wrote, "Every six weeks, we meet as a group with other Mathlete students from other schools to discuss ideas from each six weeks" (comment, teacher write-in on survey).

As the ESM Project has grown, we make efforts now to include multiple teachers from the same building so that teachers maintain a level of camaraderie that is formed as a result of participation.

Long-term sustainability of the ESM professional development

Some of the components of ESM Project model we expect will remain long after the project ends. One of the major pieces is the requirement of a math curriculum specialist in each district.

Among the outcomes of the workshops was the change in culture among the participating teachers and math specialists. As a consequence of the format of the workshops, teachers became more engaging and interactive with their peers, both from their schools and other schools. They became more receptive to their respective math specialists and they were more likely to invite them into their classrooms for help and teaching demonstrations. A personable network developed whereby teachers communicated more freely with each other, both in and outside their respective school systems. In other words, the teachers who graduated from the workshops were just as likely to seek guidance and advice from each other as that provided on the electronic highway. They embraced the notion of disequilibrium promoted by Piaget (1985): It is okay (normal) to be confused about the concepts of mathematics at the beginning. We are all still building and remodeling our mathematical world into one we better

understand. The program is removing thoughts of weakness and inadequacy among teachers.

Stumbling blocks and new developments

A recent development in state law will allow the release of teacher value-added data. In the past, these student score-based results were only available to the teacher and principal.

With increased access to student scores, we needed a new group of teachers to study. Having impacted the original districts to such a high degree, we sought out a new district that had not previously been involved, leading to the inclusion of Bristol Public Schools. The summer of 2010 will be their first involvement, and teachers from their district is will constitute over half of the teachers involved in the summer program.

Conclusion

The Eastman Scholars Mathletes program is bringing about a restructuring of the system as it pertains to building and maintaining on-going and sustained professional development in mathematics teaching and learning at the elementary and middle school levels in Northeast Tennessee. Clearly, the six participating school districts in the region are benefiting from the effects of the ETSU and ECC collaboration, and it was inherent in the participants' preparation for leadership that those benefits would be shared with other teachers in the school and school districts. Also, a major asset of the project's activities has been to establish collaborative relationships with higher education and others groups interested in improving mathematics teaching and learning. Perhaps the greatest benefit, however, is that the schools are discovering within their own ranks the leadership needed to find and follow a new impetus and direction for on-going and sustained professional development to support mathematics teaching and learning.

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