The Appalachian Math Science Partnership:

A Multi-State Umbrella Partnership Promoting Local Mathematics And Science Reform

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INVERNESS RESEARCH

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PREFACE

The Appalachian Math Science Partnership (AMSP) is a project within NSF's Math Science Partnerships (MSP) initiative. Funded at $23 million over five years, the AMSP involved 51 school districts and nine higher education institutions in Kentucky, Tennessee and Virginia.

The AMSP faced two significant challenges in its effort to live up to the vision of the MSP initiative and to its own hopes and goals. First, its service area, Appalachia, comprises some of the most isolated and stressed communities and school systems in the United States. Second, the mere scale of the partnership—60 organizations in several states—defied easy implementation. Yet despite these challenges (indeed, working to address them directly), the AMSP built upon existing leadership capacity in the region and created not only effective partnerships, but ultimately formed what we view as the foundation for a sustainable regional "improvement infrastructure" for science and mathematics.

In this set of five papers, we portray the evolution, design and strategies of the AMSP. We believe that the design principles the AMSP adhered to, the responsiveness of AMSP leaders to local needs and issues, and the strategies they devised to make good on their promise have relevance for others who invest in the improvement of science and math education, particularly in rural regions.

This paper, entitled "The Appalachian Math Science Partnership: A Multi-State Umbrella Partnership Promoting Local Mathematics And Science Reform," is the core document of the set of five and stands alone. It provides background on the initiative and on the regional landscape, gives an account of how the AMSP's overall design as an "umbrella partnership" formed, describes the major strategies and components of the partnership (including the benefits they produced and lessons learned from their implementation), documents the core values and design principles underlying the umbrella partnership, and offers our conceptualization of the AMSP as a regional improvement infrastructure.

The four papers identified as "AMSP Close-ups" are companions to this core document. Each of them focuses on an especially effective strategy or component of the AMSP umbrella partnership. Each paper defines the strategy, explains why it was developed, offers vignettes and examples of how the strategy played out in local districts and IHEs, and reflects on the particular contribution of the strategy to the AMSP. Again, our purpose is to inform the math and science improvement community about especially promising approaches to reform work involving collaboration between K-12 and IHE organizations and taking place in rural contexts or other regions where distance serves as a barrier.

The four "AMSP Close-up Papers" include:

- The Regional Program Coordinators: Making Connections and Developing Local Leadership
- Baseline Improvement Sites and the Program Improvement Review: Promoting School-Wide Involvement in Math and Science Reform
- The Partnership Enhancement Program: A Strategy for Supporting Locally Designed Partnerships
- Motivating Change in Institutions of Higher Education Through Collaboration With K-12 Partners

I. BACKGROUND

The Math Science Partnerships Initiative

The Math Science Partnerships (or MSPs) are a series of multi-year, math and science focused, educational improvement grants first awarded by the National Science Foundation in the early years of the new millennium. The MSPs, by design, have funded innovative collaborative efforts between K-12 institutions, institutions of higher education (IHEs) and community organizations aimed at achieving common educational goals. Unlike the NSF's systemic change initiatives of the 1990's, the MSP initiative is based on the assumption that improving the teaching and learning of math and science education requires that K-12 institutions join with IHEs share resources and engage in collaborative work that is mutually beneficial to both. While other NSF efforts to improve math and science education have also involved combinations of higher education and K-12 partners, most of these have expected IHEs to provide solutions in the form of services and expertise to K-12. In contrast, the MSP initiative mandated that the partnership element be a win-win, or "gain-gain," for all involved. MSP partnerships must be designed such that all members contribute and all members benefit.

NSF identified these "key features" for work carried out by MSPs:

- An MSP must be "PARTNERSHIP DRIVEN," meaning the work of the partnership is at the center of all project activity.
- An MSP must generate "TEACHER QUALITY, QUANTITY & DIVERSITY," providing opportunities for the growth and improvement at all levels of the education system K-16 and beyond.
- An MSP must use and create "CHALLENGING COURSES & CURRICULUM," again at all grade level bands.
- An MSP must reflect "EVIDENCE-BASED DESIGN & OUTCOMES" in all aspects of its work.
- An MSP must work towards having a long lasting impact by achieving "INSTITUTIONAL CHANGE AND SUSTAINABILITY."

The MSP Initiative's first request for proposals, which appeared in early 2002, had two categories of award: targeted and comprehensive. "Targeted" MSPs were aimed at a specific locality, generally involving one or two school districts and one or two higher education institutions. "Comprehensive" MSPs, in comparison, were much larger and more regional in nature,

involving numerous K-12 as well as IHE partners. The first group of MSP projects received initial funding during the Summer of 2002; these were five-year awards in which the third to fifth years of funding were conditional on projects having made satisfactory progress during the first two years.[1]

Among the first and largest of NSF's "comprehensive" MSP awards was the Appalachian Math Science Partnership, or AMSP, which was a total of more than $23 million over five years. The AMSP involved 51 school districts and nine higher education institutions in Kentucky, Tennessee and Virginia as formally designated partners.

The Educational Context of Appalachia

Rural poverty and insular social systems

To understand the AMSP, it is critical to know something about the context in which the project has undertaken its work, particularly the extent to which economic challenges continue to color so many aspects of life in Appalachia. More than forty years ago, President Lyndon Johnson established the Appalachian Regional Commission (ARC) to address the pervasive, multi-generational poverty in this rural region. In the decades that followed, the rate of poverty clearly declined, from 31% in 1960 to 13.6 percent in 2000. In addition, the percentage of adults with high school diplomas (or the equivalent) has increased by almost 70%. Still, some hard facts remain. Of the 410 counties that constitute Appalachia, only eight are at or above the national average with respect to indicators such as per-capita income, poverty rate and the percentage of unemployed. A closer look at these eight counties indicates that they are all either urban or suburban, many located on the Appalachian fringe. It is in the central counties of Appalachia, particularly in eastern Kentucky, that poverty remains the most severe. Of the 77 counties currently classified by the ARC as "distressed," 32 are in eastern Kentucky (see www.arc.gov) and 25 are designated AMSP counties. In these areas, poverty rates are double the national average.

Poverty in Appalachia spans generations—from immigrant families at the turn of the century who settled in the "hollers" and labored in the coal mines, to current residents trying to eke out a living working long hours for low pay at places like Wal-Mart and McDonald's. In addition to the challenges of extreme poverty, there are numerous geographic and topographic factors that contribute to the remote, isolated character of many Appalachian communities. The mountains that define the region create

[1] The NSF awarded a second round of MSP grants in 2003 and the initiative continues to the present. However, the MSP "comprehensive" grants were only awarded for the first two years of the MSP initiative. The remaining grants were either "targeted" partnerships or "institute" grants (see http://www.nsf.gov/ehr/MSP).

barriers that affect physical access, communication and availability of technology.
Within this environment that promotes insularity, personal relationships are invaluable. Individual communities operate autonomously, and locals tend to view outsiders with considerable wariness and distrust. Natives have a deep sense of place with strong ties to the land that is uniquely Appalachian. Families often make it a high priority to stay put and to stay together; it is not uncommon to have three or four generations living within close proximity to each other. There are also strong traditions of social stratification, often manifested as a respect for titles and deference to hierarchy.

The Appalachian education landscape

As with many rural communities, the counties and school districts in Appalachia have a history of local control and decentralization. This longstanding tradition, combined with a respect for social hierarchy, has shaped not only the structure of educational institutions, but their decision-making processes as well. For example, in some counties, particular families have occupied administrative positions in the district for generations. Community members typically defer to an individual due to his or her title and educational standing. At the same time, there is considerable ambivalence toward schooling in general: achievement in school is viewed as a mixed blessing because those who succeed often leave the region in order to follow other pursuits such as college, better economic opportunities and different ways of life.

Schools and districts in Appalachia generally operate as independent entities and they tend to be quite stable with respect to personnel. While the states take strong policy stances for educational improvement, these local systems suffer from low capacity to improve themselves, not only for reasons of tradition and isolation, but also because of a persistent shortage in the region of resources for improvement, particularly in math and science. Recognizing this issue and the widespread need in Appalachia, the National Science Foundation has invested significantly over the last ten years in a number of targeted math and science improvement efforts in the region. As a result, the AMSP has had an opportunity to do something that many of its predecessors did not—namely, to build on and contribute to other regional efforts to improve mathematics and science education in Appalachia.

History of science and math reform in Appalachia

Despite its history of poverty and low capacity for educational improvement, the Appalachian region is no stranger to math and science reform efforts. Since the mid-1990's, the NSF has generated a portfolio of investments in Appalachia. The extent to which this series of NSF investments laid a foundation for AMSP's work cannot be understated. At the time that NSF awarded the AMSP, it was the ninth initiative to be funded in the region

aimed at improving math and/or science education.[2] Including the AMSP, these projects collectively have served six states and approximately 120 counties, reaching nearly 800 schools, about 16,000 teachers and approximately 320,000 students in grades K-16.

Viewed as a portfolio, these initiatives represent a combined NSF investment of $67 million dollars and 47 collective project years aimed at strengthening math and science education in the Appalachian region. From the outset, the designers of the AMSP understood that it would not be enough to simply continue the work of any one of these prior efforts. Instead, they envisioned the Appalachian Math Science Partnership as a mechanism for enhancing and extending NSF's longstanding decade-long investment in the region. This conceptualization would prove important to the AMSP's success.

Status of partnerships between K-12 and Higher Education

While there may have been a strong history of math and science reform prior to the funding of the AMSP, the same cannot be said of the region's experience with educational partnerships, neither within the K-12 and IHE sectors nor across them. Only a few counties and school districts had ever worked together before joining the AMSP, and when they had, it was generally for cost sharing and unrelated to math and science education. Among the IHEs, only a few faculty in our initial AMSP interviews reported a significant history of collaboration; most had only rarely, if ever, met with their colleagues at other institutions.[3] Only two of the IHEs had pre-existing K-12 outreach programs that involved faculty members providing service to schools and teachers. None had ever experienced—and at the outset, many could not imagine—any sort of truly collaborative, mutually beneficial partnership between IHE faculty and K-12 educators. In this respect, the AMSP was operating in completely new territory.

The Appalachian Math Science Partnership

Project leaders

The University of Kentucky (UK) has served as the fiscal agent for the grant and housed most of the AMSP project leaders. The Executive Team comprises six people, all with prior experience working to improve math and science education in Appalachia:

[2] The table in Appendix A identifies eight other NSF projects that were either active or concluding their work at the time of the AMSP funding.

[3] Two prior NSF projects in Kentucky—PRISM (SSI) and MGMTN (Teacher Enhancement)—attempted to connect faculty from public and private IHEs in planning and operating regional professional development. These tended to be individual connections, rather than institutional ones. Still, AMSP built on these relationships as it formed working groups for various initiatives, course development teams as an example.

Paul Eakin	*Lead PI* and Professor of Mathematics at UK
Ron Atwood	*Co-PI* and Professor of Science at UK
Carl Lee	*Co-PI* and Professor of Mathematics at UK. Also Co-PI for ACCLAIM, a NSF-funded center concurrent with AMSP
Steve Henderson	*Co-PI* and Science Educator at UK. Also Project Director for ARSI, a NSF-funded project preceding AMSP
Wimberly Royster	*Co-PI/Project Director* and Emeritus Professor at UK. Also Lead PI for ARSI. Former Dean of the College of Sciences, Dean of the Graduate School, and Vice Chancellor for Research at UK
John Yopp	Project Director (beginning 2004). Associate Provost for Educational Partnerships at UK.

Much of the vision for the AMSP stems from the dedicated efforts of Dr. Wimberly Royster. Dr. Royster came to the University of Kentucky as a graduate student in 1946, where he later became a faculty member and served as a leader on campus for over 50 years. A Kentucky native, he has become a national leader and advocate for investing in rural mathematics and science improvement, a role he has largely played following his retirement from the University of Kentucky. Dr. Royster's boundless energy was also instrumental in creating ARSI,[4] one of the most successful NSF precursor investments to the AMSP. During Year 4, Dr. Royster stepped down as full-time Project Director, with Dr. John Yopp selected to fill that role for the remainder of the project. Dr. Royster continued working with the AMSP leadership in retirement on a part-time basis.

Partner institutions

While there have been some shifts over time, for the most part, membership in the AMSP has been consistent over the course of the grant. Kentucky, Tennessee and Virginia have participated in all five-plus years of the AMSP effort; West Virginia was a latecomer, joining at the end of Year 4. Within these states, a total of 38 central and eastern Kentucky school districts, eight Tennessee school districts, and five western Virginia school districts have contributed to the work of AMSP as designated K-12 partners. Also within these states, the following colleges and universities have served as designated IHE partners:

[4] ARSI, the Appalachian Rural Systemic Initiative, spanned six states and focused on improvement of science (also some math and technology), grades K-14. Key leaders from ARSI became integral to the AMSP work. For an in-depth portrayal of ARSI, see the Reports page at www.inverness-research.org.

University of Kentucky
University of Tennessee
University of Virginia at Wise
Eastern Kentucky University
Kentucky State University
Pikeville College (Kentucky)
Union College (Kentucky)
Somerset Community College (Kentucky)
Marshall University (West Virginia)

Of these, only Union College was unable to fully participate, largely due to personnel changes.

In addition to the K-12 and IHE partners, a collection of other institutions has also contributed to the AMSP initiative, usually through funding. These include the Kentucky Science and Technology Corporation (KSTC), a private non-profit working to advance education, entrepreneurship, and economic development in the state; the Prichard Committee for Academic Excellence, a non-partisan citizens advocacy organization in Kentucky; the Appalachian College Association; Kentucky Gear-Up, a federally funded college-readiness program; and the Toyota Corporation.

The award

The original AMSP award was for $22 million, to be distributed over a five-year period. However, with multiple supplemental NSF grants aimed at improving the Partnership Enhancement Program combined with the project's no-cost extension request, the total funds awarded will ultimately top $23 million distributed over six years. As fiscal agent, the University of Kentucky has overseen the allocation of monies to partners. By design, the plan for allocating grant funds was not set in stone at the outset of the grant. Instead, that process evolved according to the work of the grant. (See the section below called: *Evolution of the AMSP Design and Work*.)

Outcomes and strategic goals

Two over-arching goals guided the original design and work of the AMSP at all levels:

- *To eliminate the "achievement gap" in K-12 science and mathematics education in the region*

- *To build an integrated K-16 education system that supports a diverse, high-quality mathematics and science teacher workforce*

For the NSF proposal, AMSP leaders analyzed data from multiple sources to assess the current status and needs of the target region. They then used these data to identify five long-range outcome areas—each to be accompanied by benchmarks—that they hoped would be impacted by the work of the AMSP:

1) *Increased mathematics and science learning for all students, leading both to improvements in overall performance and elimination of gaps among subgroups of students.*

2) *Increased enrollment and successful completion of students in advanced mathematics and science courses, including elimination of differences in course-taking/completion patterns by subgroups of students.*

3) *Increased student entry into and successful completion of college/university programs for mathematics, science, technology, and mathematics or science teaching.*

4) *Increased numbers of well-prepared preK-12 mathematics and science teachers delivering high-quality instruction in a well-aligned and supported program.*

5) *Increased numbers of preservice mathematics and science teachers entering the profession well prepared to deliver high-quality standards-based instruction.*

Further, they articulated four strategic goals to align with the outcome areas:

1) *Improve the preservice training of mathematics and science teachers by implementing a rigorous preparation program designed specifically to meet the needs of preK-12 teachers, including developing appropriate content and modeling appropriate pedagogy.*

2) *Improve preK-12 inservice mathematics and science teachers' knowledge of both content and pedagogy by implementing a program of ongoing professional development, including support for effective classroom implementation of the knowledge and skills learned.*

3) *Increase students' access to career options in mathematics, science, and education by enhancing opportunities and access for all preK-12 students to engage in advanced study, career exploration, and mentoring.*

4) *Increase stakeholder and community expectations and support for mathematics and science reforms by building and utilizing leadership among teachers, administrators, parents, and higher education faculty.*

Implicit in these goals is the AMSP belief that achieving its mission would entail systematic effort to foster collaborative work within and among the partner districts and higher education institutions. It is also worth noting that the AMSP views preservice and inservice professional development as segments on a continuum that spans a teaching career.

Initial structure of the work

Three areas of concentration: Math, Science and Implementation

As originally conceived, the AMSP divided its work into three areas: Math,

Science and Implementation, with a Co-PI coordinating each division. The logic of this structure was that the Math division would undertake the work of designing and delivering preservice courses and inservice programs related to mathematics. The Science division would undertake the work of designing and delivering courses and programs related to science. And the Implementation division would help schools and districts embark on the path of improvement—generating awareness about and interest in AMSP offerings, and providing schools and districts with access to Regional Coordinators. In addition the Implementation division would be responsible for arranging local mentors for teachers trying to implement classroom changes based on AMSP professional development, and designing new AMSP strategies aimed at meeting the expressed needs of the K-12 partners. This three-part structure was not only functional but was established because it was best aligned with the given skill sets of the Co-PIs.

The AMSP also designated three Advisory Councils or Steering Groups, one for each area, led by the respective Co-PI. Membership on the Advisory Councils included project participants from IHE and K-12 institutions. Their role has been to help identify needs, to offer input on new developments or initiatives, and to provide feedback regarding existing strategies. In addition, Advisory Council members have been viewed as local point people who could identify local resources and programs that might support the larger AMSP effort and also promote the AMSP among local stakeholders.

Management Team

With respect to regional leadership, the Management Team has served as a key mechanism for distributing leadership and decision-making across the project. The group consists of the Executive Team (the PI and the Co-PIs) as well as representatives from various AMSP partners, including a superintendent of schools, a school district liaison, a school teacher, an ARSI Resource Collaborative Coordinator, and the local PIs from the eight participating IHEs beyond UK. The Management Team works collaboratively to set policy, oversee budget, review AMSP activities, assist with implementation, and plan for the future. Together this group plays a pivotal role both in leveraging local resources and garnering broad-based support for the AMSP work.

Below is a more detailed description of the role of the Management Team in the AMSP.

Providing the Scaffolding for Regional Reform: The Role of the Management Team in the AMSP's Umbrella Partnership

Background

With a total of 50+ K-12 school districts as well as nine colleges and universities serving as higher education partners in the Appalachian Math Science Partnership, some sort of regional leadership structure was critical. Among the IHEs, each selected an administrator who would serve as the Local-PI for the grant and the institution's representative to the AMSP Management Team. This group, consisting largely of K-12 administrators, teacher leaders, IHE deans and department chairs, met on a regular basis from the outset of the project. Together, they not only established a strong, collaborative start for the initiative but also evolved into a responsive, middle-level leadership team that would serve the AMSP for the duration.

Just as the AMSP colleges and universities varied as a group, so too did the people who represented these institutions on the Management Team. Below is a list of the participating IHEs and title of each of the Local-PIs associated with each one. Note: University of Kentucky (UK) is not included in the table because, as the fiscal agent, UK did not have a Local-PI. Instead, all Co-PIs at the UK served on the AMSP Management Team.

IHE	Local-PI
Eastern Kentucky University Assoc.	Dean of the College of Arts & Science
Kentucky State University	Chair of the Mathematics Department
Morehead State University	Dean of the College of Science
Pikeville College	Academic Vice President
Somerset Community College	Mathematics Department Chair
Union College	Professor of Graduate Education
University of Tennessee	Associate Dean of Arts & Sciences
University of Virginia at Wise	Academic Dean

A Connective Initiative
Like other components of the AMSP initiative, the work of Management Team evolved over time. In the early years, the members of this group played a pivotal role in shaping policy that was likely to meet with the approval of all IHE partners. However, throughout the initiative, each Local-PI acted as the critical point of contact between his or her home institution and the project—managing the fiscal challenges of the partnership, shepherding the required data collection, garnering support for project-wide initiatives such as course development teams, and providing local interpretation of the AMSP vision. A particular challenge for the Local-PIs as the AMSP began its work was determining the best role for their particular IHE in the larger partnership and then negotiating adequate buy-in from the various constituents within their institution. For example, at most IHEs, one group of faculty was enthusiastic about being involved in the AMSP, while another group needed convincing. Similarly, all members of the Management Team also found themselves navigating territorial issues between departments, especially when it came to modifying courses for preservice teachers. However, members of the group also supported each other in times of difficulty, learning from the experiences of the different institutions and finding leverage in their collective action as a Management Team.

Generative Structure
As the AMSP continued to refine its work, the Management Team's distributed leadership model enabled the project to respond to evaluator feedback, and to adapt to emerging project needs in a regional fashion. But even more importantly, the network of AMSP IHEs and their designated local-PIs provided a structure for growing new elements of what came to be referred to as the "umbrella partnership." As opportunities for IHEs surfaced in the project, members of the Management Team paved the way for involving their home institution in the emerging strand of work. They acted as liaisons, connecting people in their institution with colleagues at other AMSP colleges and school districts. Local-PIs also played a critical role in shaping and interpreting AMSP policy so that it would apply readily and with minimal conflict across multiple institutions.

The Seeds of Regional Infrastructure
Not surprisingly, it was the members of the Management Team who first (only three years into the AMSP grant) began raising issues of maintaining the critical work of the AMSP beyond the grant period. Having experienced firsthand the benefits of the initiative to their college and local region, they pushed on each other to consider ways that each of their institutions could contribute to furthering the work in the years to come. At a Management Team retreat, small groups contemplated the future, ultimately leading to a vision that involved a network of colleges, each connected to local schools districts and many housing Regional Program Coordinators. While their original vision is not exactly the model that ultimately resulted, as a group, they have embraced the notion of partnership as embodied by the AMSP and are determined to play a role in creating the infrastructure that will allow the Appalachian region to maintain a steady course of K-16 math and science improvement beyond the funding period of the AMSP.

AMSP Advisory Board

As with almost any project of this size and scope, the AMSP also appointed a national Advisory Board—a group of well-known and highly respected education professionals representing math, science, elementary, secondary and post-secondary education. The board met annually to receive updates on the work of the partnership, to hear about accomplishments and challenges, and to advise AMSP regarding the future direction of the project. They provided external oversight and feedback separate from the project's evaluation team. Below is a list of those who served on

the AMSP's national Advisory Board:

Dr. Lois Adams-Rodgers	*Program Director, Council of Chief State School Officers*
Dr. Rowena Douglas	*Assistant Executive Director Professional Development, National Science Teachers Association*
Ms. Carole Kennedy	*Consultant, National Board of Teaching Standards*
Dr. William Kirwan	*Chancellor, University System of Maryland*
Dr. Bernard Madison	*Department of Mathematical Sciences, University of Arkansas*
Dr. Daniel Maki	*Chair, Department of Mathematics, Indiana University*
Dr. Ertle Thompson	*Professor, Curriculum and Instruction (Science Education), University of Virginia*
Dr. Robert Yager	*Professor, Curriculum and Instruction (Science Education), University of Iowa*
Dr. John Yopp	*Vice President, Graduate and Professional Education, Educational Testing Services*

Inverness Research

Our role as external evaluator

We at Inverness Research served as the external evaluator for the AMSP. Since the pre-proposal stage, we have worked closely with the AMSP leaders and staff to document the evolving design of the initiative, to study the field-based realities of the work, and to report our findings to the project leadership. We often refer to ourselves as the AMSP's "critical friends," meaning that while we are independent of the project, we want our evaluation work to serve as third-party feedback that will contribute to its success. Our primary function has been what we call "ground truthing," that is, collecting data in the field and then assessing the extent to which what is actually happening within the project is congruent with the assumptions and strategies of those leading the work.[5]

In addition to the AMSP, Inverness Research has studied a number of NSF-funded projects seeking to improve mathematics and science education in the

[5] Appendix B lists Inverness Research evaluation activities and types of data gathered over the five years.

Appalachian region.[6] Our growing experience in Appalachia, as well as in other rural areas, informed the framing of our evaluation and our conceptualization of the design of the AMSP. Two other factors also shaped the focuses of our study. First, the AMSP had an internal data collection and evaluation team that was charged with gathering baseline data from the participating partners and evaluating specific activities such as teacher institutes. In our research, we wished to draw from but not duplicate this work. Therefore, our study focused on the broader strategies and designs—the partnership structure and management, the overall design and implementation—so as to gain insight that could inform the development of the project during its evolution and also produce lessons learned for the field.

During Years 1–4, our team placed considerable emphasis on clarifying the AMSP's theory of action, examining and helping to conceptualize its design, and assessing the nature and quality of work associated with the project's several strands of investment. Our work during this period was almost exclusively formative. In Years 5–6, our work has shifted to a more summative purpose, with a focus on documenting the AMSP's strategic design and illuminating lessons that are germane to others working for the improvement of math and science. This set of papers is a product of this latter phase.

An initial perspective on the conditions for AMSP work

When we began our work with the AMSP, it was readily apparent that this highly complex, wide reaching initiative would face considerable challenges in trying to achieve its goals. Many were challenges that any project of this size and scope would face, but they were amplified by the Appalachian context. It was equally clear that the project also possessed significant assets that might be leveraged to overcome potential barriers. In the early days of the initiative, many of our discussions with AMSP leaders focused on these challenges and assets. While we have alluded to some of them above, we offer a summary below to indicate how we viewed these conditions as the AMSP embarked on its work.

[6] Members of the team from Inverness Research have been involved in studying the Appalachian Rural Systemic Initiative (ARSI); Project CATS; the ACCLAIM Center for Learning and Teaching; Coalfield Rural Systemic Initiative; MERIT; and WV Handle on Science. See the Reports page at http://www.inverness-research.org for a monograph on lessons learned from ARSI.

Challenges	Assets
• many school districts covering a wide geographic area • rural isolation • high poverty • low capacity for educational improvement • range of prior experience with math and/or science reform • no existing mechanisms for collaboration among IHEs or between IHEs and school districts • high degree of local autonomy • little awareness of national improvement efforts in math and science	• prior NSF investments in Appalachia • recent success with ARSI and some overlap in participating counties • experienced group of key players • supportive state policies with respect to reform • genuine desire to improve teaching and learning • desire to better serve students and their families • IHEs interested in outreach • federal mandates pressuring for change

II. THE AMSP AS AN UMBRELLA PARTNERSHIP

We have organized our discussion of the design of the AMSP as a chronology of AMSP development. The narrative structure enables us to show how the conceptualization of the umbrella partnership both emerged from and helped to re-shape the management, activities, and outcomes of the AMSP mid-course; that is, to show how form and function ultimately worked together to refine the AMSP into a very strong model for rural educational improvement. We hope the narrative structure also helps convey some of the real-world struggle involved in finding the right design for new and very complex work. Presenting the model as an *a priori* concept would belie the effort involved in addressing the challenges of educational improvement. We feel that the resultant model has promise for math and science educators engaged in similar work in other rural places.

Evolution of the AMSP Design and Work

Launching the initiative

Although the AMSP leaders had submitted a detailed proposal, the prior thinking only mildly softened the hard reality that hit in the fall of 2002 as they suddenly needed to make a plan for spending $22 million over the next five years—they needed to get started right away. They needed to spend more than $4 million per year in a widely diverse region where these was still scant capacity for improvement and few professional relationships among partners. They knew that decisions about how to spend the money during the first year would have serious ramifications for the remaining years, and they wanted these early investments to yield good returns.

Prudently, they started from a position of strength and high potential. The most well established working relationships at the outset of the project were among the IHE partners; thus the work began there, with developing preservice courses and creating summer institutes for teachers.[7] The course development teams included K-12 teachers, but by and large, during the first year, the AMSP effort focused on bringing the IHE partners together and letting key faculty members begin the work of designing and delivering courses according to the three divisions explained above: Math, Science and Implementation. As a result, the majority of the first-year funds flowed to the nine IHEs.

The AMSP's decision not to simply distribute the funds to all of its more than 60 partners would prove to be a critical one. The AMSP leaders wisely understood that it would be wasteful because in Year 1, most were not ready to begin the work of the grant. Instead, the leaders knew that the AMSP

[7] See the *AMSP Close-Up* on this collaborative process and its impact on IHEs.

would need to evolve, and as it did so they would need to invest in the people and activities that would best meet project goals. This decision, while wise, meant there was significant under-spend in that first year.

Getting it going—Year 2

Particularly for a project of its size, the AMSP got off to a strong start its first year. The course development teams began work in the fall and the IHE partners seemed genuinely enthusiastic about working together. In Year 2 the Math division succeeded in launching the AMSP-influenced "Math for Teachers" courses project-wide, and the Science division took the lead in implementing pre- and post-testing as a means of documenting content knowledge gains connected to its Physics and Chemistry offerings. These were degree credit math and science content courses offered as a part of a program of study leading to a teaching license at the K-12 level. The Implementation division put considerable energy into cultivating local reform leadership project-wide (expanding the Leadership Interns program and launching the "Leading by Design" principals' program), while simultaneously broadening the work of the Regional Coordinators to include district-based offering like "Using Data, Getting Results." Teachers who participated in the first set of two-week intensive Summer Institutes raved about the quality of their experience, many claiming that it was the most worthwhile professional development in which they had ever participated.

The work of the three Regional Coordinators[8] was also critical to the accomplishments of Year 2. Regional Coordinators serve as AMSP liaisons, helping to connect K-12 partners to the work of the initiative and to broker connections between the appropriate K-12 and IHE partners. Year 1 had seen the successful hiring of three people for these positions: one housed at University of Virginia at Wise, one at University of Tennessee, and one at University of Kentucky. All are experienced educators with established careers and connections in the region that they can leverage for the purposes for forwarding the AMSP work. They were immediately and deeply immersed in their new work at the outset of Year 2. Working mostly individually but sometimes in tandem, they held multiple improvement planning meetings in nearly every one of the AMSP school districts, and facilitated some sort of professional development for more than half. In a relatively short span of time, these AMSP-supported leaders developed the know-how to connect IHEs and schools, link up districts with shared interests and goals, steer schools and districts in the direction of AMSP program improvement opportunities, and act as a liaison between AMSP project leaders and partners. In future years a fourth Regional Coordinator was added.

Year 2 also brought significant challenges. At every turn, AMSP leaders confronted the task of locating people with high capacity to advance the

[8] See the *AMSP Close-Up* on the Regional Coordinator role, which includes illustrative cases.

goals of the initiative. In doing so, the shortage of experienced educators available to do what needed to get done was becoming increasingly apparent. AMSP leaders expressed interest in making better use of experienced people from prior projects, especially because it had emphasized the development of local math and science leaders. NSF had cautioned AMSP leaders from the outset that they were not to simply continue ARSI with the AMSP funds. Therefore, project leaders were cautious about immediately tapping into this valuable resource. However, as the work proceeded in Year 1, they wisely recognized that AMSP needed to tap into all available local capacity, as well as working to cultivate additional leadership in the remaining years of the grant. In the fall of Year 2, AMSP hosted a conference bringing together dozens of Appalachian educators who had participated in some of the earlier NSF grants, the goal being to share information across projects, identify avenues of potential collaboration, and foster commitment to working with the AMSP.

Further, although many successful AMSP activities had taken place by the end of the year, there was little apparent connection across the different elements of the work. The contribution of K-12 to the larger partnership was especially unclear: thus far, K-12 participants tended to be recipients of services rather than active partners. Likewise, many designated K-12 partners were raising concerns about the extent to which IHEs had access to grant funds in a way that K-12 partners did not. Many felt they knew what their district needed to improve and wanted to take action with financial support from AMSP. In response to such concerns and in consultation with members of the partnership, the external evaluation team, and the funder, AMSP launched a new strategy at the end of Year 2: the Partnership Enhancement Program (PEP).[9] The PEP grants were conceived with a model of micro-investment in mind. By design, they required one or more school districts to partner with one or more IHEs to design and carry out local work supporting math and science reform. PEP grants were thus the AMSP's first direct investment in locally defined partnerships and work. The first awards were up to $30,000 and funded approximately one year of work, generally an academic year (summer to summer).

The NSF Phase One site visit—A critical juncture

The notion of the Partnership Enhancement Program surfaced only months before the NSF Phase One site visit. Some might argue that the impending arrival of NSF helped spur this development, which specifically responded to needs of the K-12 partners. It is important to recall that the NSF site visit was an extremely high stakes, comprehensive review that largely determined whether the AMSP would receive the remainder of its funding. Project personnel began preparing for the review months before it actually took place. Our evaluation team met with the AMSP Executive Team in the

[9] See the *AMSP Close-Up* on the Partnership Enhancement Program, which includes illustrative cases.

spring both to share findings from our recent fieldwork and also to advise project leaders as to key issues that needed to be addressed for the NSF program officer and her team.

As the external evaluators, our primary concern was the extent to which the AMSP's theory of action—the logic model for how the project would achieve its goals—remained somewhat unclear, both in the overall conceptualization of a regional multi-institutional partnership and in the linkages of the various components. In our "critical friends" role, we also struggled to make sense of the complexities of the AMSP. We felt that the Management Team could probably not effectively orchestrate the AMSP work from the center of single, large-scale partnership with more than 60 members. In fact, their recent decisions—including the creation of the PEP grants—indicated that they already knew this but simply had not stated it explicitly. Through reflection on the AMSP's goals, the challenges it faced, the assets available for its work, and the steps it had taken during its first two years, we ultimately formed a concept that we thought could be helpful both in explaining and in shaping the project as it matured: the AMSP as an "umbrella partnership." An umbrella partnership would not be one vast entity coordinated by UK or any other group. Instead it would operate as a generative structure, fostering many local and regional partnerships, all doing work aligned with the larger AMSP goals.

We presented this idea to AMSP leaders before the NSF site visit, and project leaders found it congruent with their own evolving but still tacit vision. They also saw that this conceptualization would have implications for project management and distribution of funds in future years. At the NSF site visit, the visiting team also found the concept useful as a model for the AMSP. By the end of the visit, terms like "umbrella partnership" and "strands of investment" seemed to have become part of the AMSP discourse. After a successful visit, NSF awarded the remaining funds.

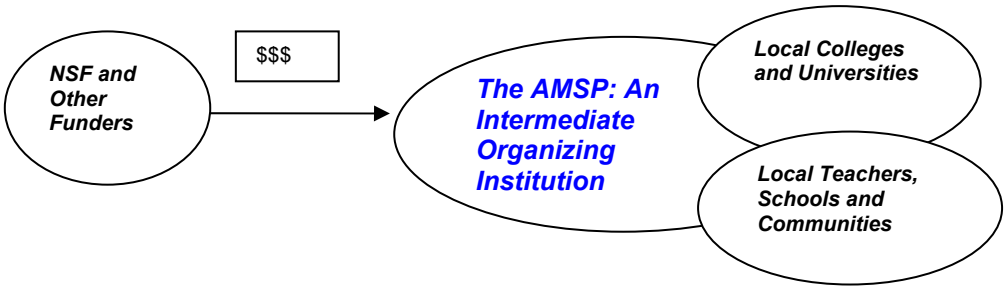
Conceptualizing the AMSP as an Umbrella Partnership

Conceptualizing the AMSP as an umbrella partnership involved, first, positioning the AMSP as an "intermediate organizing institution," and second, defining its primary function as making "micro-investments" in local partnerships and work.

AMSP as an intermediate organizing institution

This kind of organization does not function primarily as a service provider; rather, it serves as the interface between the funder and the widely distributed local schools and colleges who benefit from the funding.

Figure 1.
The AMSP as an interface between funder and multiple participating institutions



We have learned from our research on other projects that to create a successful interface between the funder and local beneficiaries, the intermediate organization must be highly principled and goal-oriented in its linking function. During Year 2, we observed the following principles evolving as guides for the operation of the AMSP. These strengthened its potential to serve as an intermediate organizing institution:

- *Research findings and national standards continuously shape AMSP work.* The leaders of the AMSP are well connected at the national level and cognizant of the latest research and vision for high-quality math and science education. AMSP supports local work that promotes movement toward this national vision.

- *AMSP work is respectful of and responsive to the interests, values and wisdom of local communities.* While the work of the AMSP was always mindful of national standards, it was becoming increasingly responsive to local concerns and issues.

- *The AMSP has a primarily capacity-building function.* Increasingly, the AMSP defined its role as involving local colleges and schools and building their capacity. It would not achieve its goals only by funding services and activities for teachers and students. Rather, it was striving to structure its work so its programs also created enduring capacity.[10]

Micro-finance as a model for supporting local partnerships

Even positioned as an intermediate organizing institution, the AMSP needed to define its relationship and role with respect to the participating institutions, which were many, often small, and were distributed far and wide. There were the formally designated partners—nine institutions of higher education, and 51 school districts in three states—and also other districts, other colleges, and other reform efforts throughout the region. The simple dyadic relationship consisting of one university and one school district, which is the model for many MSPs, was simply not viable for the AMSP. Rather, we envisioned the AMSP as an "umbrella partnership" that would be generative of numerous smaller working partnerships throughout the region.

We envisioned "micro-finance" as a concept that might apply to the structure and distribution of resources this umbrella partnership.[11] We saw two key characteristics of a micro-finance approach that would apply to the problem of a large entity supporting local educational improvement. One is that the funding agent pursues small grants to local individuals and small groups with the goal of empowering local people to develop their own capacity. The second is that the organization that supplies and monitors the funds is providing a transparent structure and guiding principles for the investment. In a similar way, the AMSP would develop strategies for investing in local K-12/university partnerships within Appalachia that would empower local educators, address national standards, serve local needs, and contribute to the AMSP project-wide. Within the micro-investment strategy, the AMSP would operate under "an ethic of performance," meaning funding would be contingent on doing good work.

Defining the strands of investment for the umbrella partnership

To generate meaningful working partnerships in this vast region, the AMSP would have to pursue multiple strands of investment as a way of allocating the AMSP resources equitably and addressing a wide range of specific local

[10] For example, as the AMSP funds course development efforts, those efforts must not only develop good courses, but they must also develop future course developers. Thus, the work sponsored by the AMSP must leave behind an increased capacity for doing future improvement work.

[11] Micro-finance is a strategy undertaken by the World Bank and others for small-scale, local investment targeted at alleviating poverty, primarily in under-developed countries.

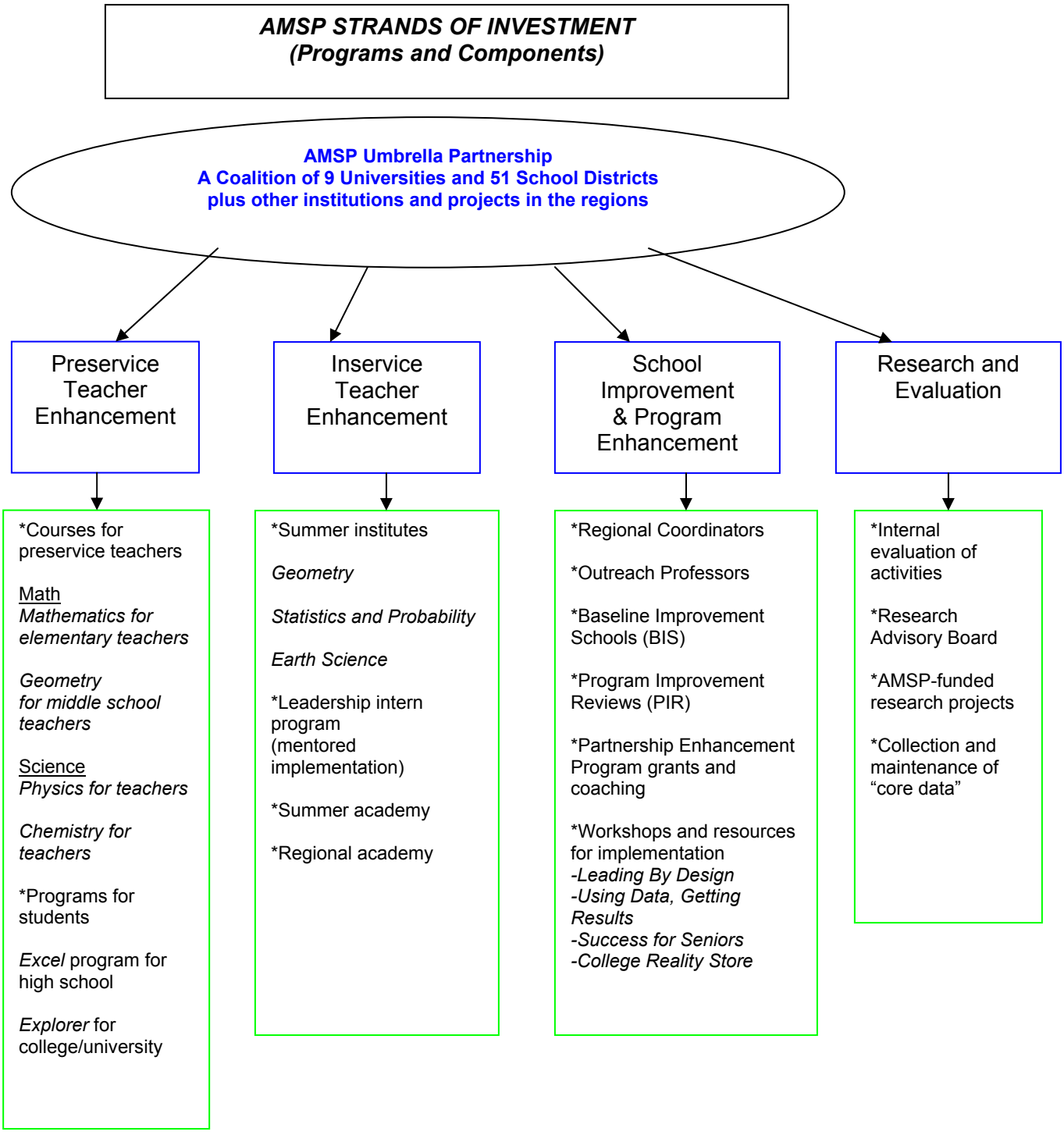
needs. Based on the work we had observed during the first two years, and wishing to help organize and advance its development, we proposed to the Executive Team a model with six designated strands of investment.[12] Within each strand we envisioned multiple programs and components. During Year 3 (discussed further below), the Executive Team embraced the "umbrella partnership" model as their own and engaged in the considerable work to make it operational; in so doing, they collapsed the proposed six into the following four strands of investment:

- **Preservice Teacher Enhancement**
  - *implementation of preservice courses designed by collaborative team of university faculty, with assistance from a few K-12 teachers*
  - *programs that allow undergraduate and advanced high school students to experience teaching mathematics to their younger peers*
- **Inservice Teacher Enhancement**
  - *intensive summer institutes on math and science, collaboratively designed by teams consisting of university faculty with help from K-12 teachers*
- **School Improvement & Program Enhancement**
  - *support for schools and/or districts to engage in self-study and data-driven self-improvement*
  - *support for a variety of positions, programs and activities that contribute to building the expertise needed to sustain ongoing improvement in the region*
- **Research & Evaluation**
  - *Data collection and focused studies that contribute to region-wide vision, relationships and shared work*

The diagram on the following page portrays this design and the work that would be carried out within the strands.

[12] They were: Course development, student opportunities, teacher enhancement and learning, leadership development, school improvement and program enhancement, regional identity and connections.

Figure 2.
The AMSP as an umbrella partnership with strands of investment that would build local capacity[13]



[13] This figure reflects the work of the AMSP strands at approximately Year 3 (mid-point in the grant cycle).

As the AMSP continued its work, Year 2 would be viewed as among its most productive and critical years. After months of getting so many activities up and running, the summer of Year 2 was when all the pieces began to come together, bound by an emerging shared vision and clearer sense of direction and purpose.

Getting It Good—Years 3-5 and Beyond

Year 3

One of the challenges following Year 2 was determining how to operationalize the "umbrella partnership" and its "lines of investment" from a managerial standpoint. It was one thing to conceive of the overall initiative in this manner, and quite another to organize and oversee the totality of the AMSP work using this structure. Much of Year 3 focused on putting NSF's recommendations into action within this conceptual framework. For example, AMSP hired a fourth Regional Coordinator, to be housed at Morehead State University; each RC was now assigned a total of 12 to 14 K-12 districts on which to focus their individual work. The AMSP also created a new Data Manager position; this person immediately began working directly with the designers of the project's data management system in order to extract much of the data that had been collected thus far for more exploratory analysis.

By Year 3, the majority of AMSP districts had participated in some sort of AMSP offering, most often through Summer Institute participation or other district-based professional development programs for teachers. Likewise, AMSP began to penetrate to the school level by making a special effort to engage "Baseline Improvement Sites" (BISs). These are individual schools identified by districts as having special need or potential for reform. These schools served as key data collection sites for the AMSP, and received special access to AMSP programs and supports.[14] For each remaining year of the grant, district leaders would be asked to name one baseline improvement site that they believe stood to benefit most from AMSP focus and/or support.

Meanwhile, the Program Enhancement Program grants continued to grow in number and to improve in terms of the quality of work proposed. Responding to evaluator concerns about equitable access to AMSP programs, project leaders organized workshops to support the grant writing process and collaborated with Regional Coordinators to reach out to those counties and districts that had not yet participated. They also created different categories of PEP grants, such "developmental" or "expansion"

[14] See the *AMSP Close-Up* on the Baseline Improvement Site strategy for a detailed discussion of its structure and its multiple benefits.

grants so as to better accommodate the particular needs of different applicants.

What was not clear at this point was how the leadership would be distributed across the four strands given the project's original organizational structure. The AMSP now had a faculty member who headed the Research strand, and the original "Implementation" function seemed to parallel "School Improvement & Program Enhancement" without too much difficulty. However, neither the "Math" nor the "Science" Co-PI had an interest in leading the "Preservice" or "Inservice" strands. These were faculty members with discipline-based expertise, as opposed to project management experience. While the programs in the newly defined strands would ultimately get developed, the challenge of how to re-organize and oversee the details of the work would persist for the remaining years of the grant.

Significant personnel changes proved to be another defining aspect of the Year 3. Two of the original three Regional Coordinators moved on and the project successfully faced the challenge of finding not only their replacements but a third person for the recently created fourth Regional Coordinator position. More importantly, Wimberly Royster—the AMSP Project Director, co-PI and visionary—made clear his desire to spend more time in retirement. While he was still quite willing to be regularly involved in the work of the project, the AMSP needed to find someone else to shepherd and supervise day-to-day operations. As Year 3 transitioned to Year 4, this new leader was identified as Dr. John Yopp, someone who knew the AMSP well due to his role on the National Advisory Council. Dr. Yopp's leadership, combined with his skills and talents in areas of data and assessment, would mark a new era for the AMSP, particularly within the strand of investment known as Research & Evaluation.

Year 4

Year 4 reflected the positive trajectory that had characterized the AMSP from the outset. The combined efforts of John Yopp and Wimberly Royster in the Project Director role proved a force to be reckoned with. As a result, some marked progress occurred in a number of key areas. For example, the project began to use its data management system in multiple new ways. The project strengthened its investment in the research strand, which led to higher quality studies undertaken on behalf of AMSP and richer collaborations with education faculty affiliated with some of the IHEs. Based on findings from the external evaluation report, the AMSP also made a more targeted effort to address issues of access and equity in the project, designing new strategies for connecting outlying districts to the PEP initiative.

After some significant changes in a few key leadership positions during Year 3, Year 4 proved to be highly stable with respect to personnel. This continuity enabled existing partnerships to deepen and thrive while

simultaneously creating space for reaching out to those who had not participated as thoroughly in the initiative. By year's end, more than half of the K-12 partners had received PEP grants; as a result, the AMSP created a new position: that of PEP Coordinator. In addition, the University of Kentucky was well on its way to fully establishing PIMSER (the Partnership Institute for Math & Science Education Reform). This would become a new organizing entity in the emerging regional infrastructure, strengthening potential for sustainability; we discuss it further below, in Section IV.

Project leaders continued to refine the initiative's management structures, with an eye now toward more deliberately envisioning what the life of the AMSP might be beyond the grant period. The Executive and Management Teams launched a new strand of work—some it called the "development" strand—that aimed to provide a structure for continuing the K-12 math and science improvement effort in Appalachia beyond the period of AMSP funding. With time growing short, the AMSP began carefully examining its priorities and developing strategies to address some of the project's lingering challenges.

Finally, the AMSP worked in an ongoing fashion to forge new regional partnerships that would contribute to the project's goals. One new development was a supplemental award that allowed AMSP to bring on Marshall University and a handful of West Virginia counties to participate in the end years of the initiative.

Year 5

Securing a lasting legacy was the major focus of Year 5. As part of the effort to cultivate a "development" or "sustainability" strand, the project continued to identify key strategies that have contributed to its success and to explore prospects for future institutionalization and funding. For example, they wanted to make sure that AMSP-designed courses continue to be offered at the IHEs. Critical personnel positions such as Regional Program Coordinators or Outreach Professors could be continued or even expanded into other IHEs.

A key piece of the work for the "umbrella partnership" in Year 5 was to engage the remaining most remote and reticent of the AMSP-designated counties. If the early years of the grant were IHE-centered, it's fair to say that the later years were school- or district-centered. For example, within the *School Improvement & Program Enhancement* strand, Regional Coordinators focused much of their district work on the designated Baseline Improvement Sites. These schools were not only given priority access to AMSP professional development, but they were also encouraged to participate in the AMSP-endorsed PIR (Program Improvement Review)

process.[15] Particularly in the final years of the grant, an increasing number of BISs were choosing to engage in this intensive, site-based process which supports schools in identifying their own needs with respect to reform and improvement. As with so many aspects of the AMSP effort, the BIS strategy has proven to be another instance of the project providing the tools for local partners to better understand their institution, and to design work that meets their needs as well as the goals of the AMSP.

Another important Year 5 change occurred in the redesign of the Summer Institutes. These were discontinued and replaced with Leadership Institutes that involved teams from participating AMSP districts. The goal of this end-of-project modification was to focus AMSP offerings on build capacity for improvement as opposed to providing content-driven professional development for teachers. The Leadership Institutes addressed key issues that participants had identified earlier in the year through a project-wide needs assessment survey. By design, the Leadership Institutes led to district-based "Embedded Professional Development" initiatives—another vehicle for bringing the work of the AMSP to the local level.

A reflection on evolving program design

As Year 5 drew to a close, our evaluation team was struck by the effortful, yet organic, process of evolution that we had witnessed, and the remarkable progress the AMSP made in a short time. The AMSP work had begun where project leaders knew they had their best chance of getting started—the IHEs. Here, the "umbrella partnership" began forming before the evaluation team articulated it as a concept. Throughout Years 1 and 2, project leaders solicited input at nearly every turn, knowing their initial proposal was imperfect, and they embraced the perspectives that ultimately shaped their work—among them the partner institutions, NSF, and our evaluation team—particularly associated with the Phase One Site Visit. Throughout the course of the grant, project leaders accumulated and applied lessons learned from their experience, actively sought input from multiple constituents, and thus, steadily built their own capacity to design, refine and operate the AMSP.

[15] The PIR process was originally developed by ARSI. Developed further and refined in the AMSP, it is now publicly available in math and science. See the *AMSP Close-Up* on the Baseline Improvement Sites strategy.

III. REFLECTIONS ON AMSP STRATEGIES AND WORK: CONTRIBUTIONS, CHALLENGES AND LESSONS LEARNED

In this section we present our summary reflections on the work of the AMSP. We organize the discussion by the four strands of investment because these gave strategic shape to AMSP work, with each strand operating quite independently:[16]

- Preservice Teacher Enhancement
- Inservice Teacher Enhancement
- School Improvement and Program Implementation
- Research

We identify the contributions that the individual strands made to the impact and legacy of the "umbrella partnership" as well as the challenges and barriers encountered within these strands. We also propose lessons learned from these strands that have implications for the AMSP as it continues and for others involved in large-scale science and math improvement efforts.

Preservice Enhancement

This strand focused on improving the preservice pipeline for math and science teachers in the region with respect to both quality and quantity. AMSP undertook three strategies:

1) Through the work of course development teams: To offer new or improved content courses for preservice teachers. This was the major emphasis of this strand by far, and was the earliest strategy of the whole initiative.

2) *Through the Explorer program: To interest college students in math or science careers, and possibly in teaching, by giving them an opportunity to assist a math or science faculty member with instructional duties.* Two universities had existing Explorer programs when AMSP began, and the initiative helped spread them across all IHE partners.

3) Through the Excel program: To interest high school students in math and science teaching by creating opportunities for them to work with their younger peers in a math or science course. This program, initially established elsewhere, was adopted with some significant

[16] By operating independently, the strands had greater focus on their work and greater flexibility; however, this may have placed some limitations on the ability of the strands to work symbiotically towards the overarching goals of the AMSP. We address the issue of communication in the final section of this report.

adaptations by AMSP colleges and universities. This was the smallest of the three program areas within this strand.

Contributions

These contributions have in common that they produce both immediate and lasting benefits.

- New courses and quality materials for use in existing courses that constitute a lasting resource for the region and beyond:
  - Across the initiative and at multiple IHEs, there now exists a more consistent set of content-rich, standards-linked, pedagogically sound preservice courses.
  - Development teams have disseminated their work via written correspondence as well as workshops for faculty in other universities, making it possible for the approach and content of these courses to be incorporated into similar courses elsewhere.

- New instructional practices that affect new courses and have a ripple effect across others:
  - Faculty members who have participated in the course development process report changes in their classroom practice and their outlook on teaching. This new outlook includes making changes to non-AMSP courses that reflect the vision they have embraced through their AMSP work.

- New professional relationships that can be leveraged to sustain the work and for future regional benefits:
  - The professional collaboration that occurred within the course development teams has led to stronger relationships among faculty, both within participating institutions and across the region.
  - The course development process created opportunities for K-12 teachers and university faculty to learn from each other as members of the same design team, a rare experience for faculty as well as teachers. Beyond the existence of new professional connections, this experience helps break down perceptual barriers that separate members of the larger profession.

- New career visions for students: While the final results remain to be seen, we have heard powerful anecdotes over the course of the initiative about students deciding on or even changing their career plans as a result of their participation in AMSP programs:

- College students across the initiative have had an opportunity to see faculty life from behind the scenes in a way that they would not have been able to do ordinarily.
- High school students have been given a chance to teach mini-lessons for their younger peers and to consider questions about how people learn and what constitutes the big ideas of the high school curriculum.

Challenges

Many of the challenges related to this strand are inherent to any effort to foster change in individual and institutional practices. When leadership becomes spread thin as a project grows or funding shifts to other priorities, the pull of "business-as-usual" can sometimes diminish the momentum of the new work.

- Institutional dynamics: Higher education institutions, like K-12 but perhaps more so, have traditions, professional norms and policies that can inhibit innovation:
  - Initially there was some hope that change could be institution-driven and reach to science and math faculty. In reality, instructional improvement at the IHE level has begun as a personal change process for participating faculty that, through individual advocacy, begins to promote institutional change.
  - The degree of implementation of courses varied across IHEs because of the strong effect of staffing and curriculum policies. Some IHEs tended to favor modified versions of existing courses (which are "on the books") over brand-new courses.
  - AMSP courses—for example "Mathematics for Elementary Teachers" and "Physics for Elementary Teachers"—clearly promote a more student-centered and inquiry-based approach to instruction. Many individual faculty members are not fully prepared to embrace them; this can also inhibit their full implementation.
  - The nature of the relationship between math and science departments and education departments proved to be a significant factor in how AMSP courses were incorporated into an institution's program. In some cases, the courses became required content courses for preservice teachers; in others they were added to the list of program options for students to select.

- Lost opportunities for collaboration: These are reminders that networking and collaboration are not inherent to faculty lives and need ongoing, direct support:

  - Each course development team operated quite differently from one another, and their productivity has varied. There was only a modest effort on the part of AMSP to coordinate the sharing of lessons learned across teams; thus there was some lost opportunity for development of collective wisdom and advocacy.
  - Faculty members have found that opportunities for ongoing collaboration dwindle once the new course has been implemented in its intended settings.
  - The heavy focus on engaging Arts & Sciences faculty (driven largely by the funding guidelines) in the work of the initiative may have indirectly contributed to less emphasis on collaboration between Arts & Science and education faculty, which is itself a challenging endeavor.

- Shifting of attention across programs:
  - The Explorer and Excel programs, which were strong vehicles for student engagement in the early years of the AMSP, lost some of their momentum over time. As the initiative became increasingly large, complex and more focused on K-12 implementation, a lack of coordinated, project-wide leadership for these programs likely played a role.

Lessons Learned

- Faculty development in the IHE: In the discourse of reform, "professional development" often refers to that of K-12 teachers; however, the experience of the AMSP reminds us that professional development is also relevant to IHE faculty members:
  - Many IHE faculty want to work collaboratively, and they need mechanisms for doing so. The course development teams proved to be an excellent venue for this; however, additional structures—e.g., follow-up meetings or research projects related to the new courses—are needed to promote further exchange across IHE faculty and their institutions.
  - Even IHE faculty who are pre-disposed to engage in progressive math and science improvement would benefit from opportunities to learn how to use more innovative instructional strategies, particularly practices focused on "active" versus "passive" learning.
  - Faculty members do not naturally have the know-how to advocate for reform within their own institutions, e.g., to push for the integration of their new courses into existing programs. They would benefit from learning more about how to do this.

- The need for strong "shepherds" of innovative programs: Leadership is a key ingredient for the success of any program, but it is especially vital for programs not viewed as within the core mission of the IHE:
    - The Explorer and Excel student programs would have been strengthened not only by articulation of project-wide guidelines, but especially by designation and resourcing of leaders who could devote attention to and take responsibility for shepherding the work of these more peripheral, but still important, activities.

Inservice Enhancement

This strand included all project-wide AMSP professional development.

1) Summer Institutes for teachers was the major program strategy within this strand. Institutes began as two-week intensive programs and were offered in counties and districts to be within easy reach of teachers. From the outset, AMSP Summer Institutes were well-attended and widely praised for meeting a number of local as well as regional needs. The content of the institutes was closely tied to the development and redesign of courses taking place in the preservice strand. In some cases, faculty tested their ideas in a Summer Institute prior to designing a preservice course, and in other instances the course came first. Teachers who participated in the Summer Institutes also received *mid-year mentor support* in their classrooms for implementing ideas and activities. In later years, as a way to reach teachers not able or willing to devote two full weeks of their summer to these institutes, the AMSP offered *shorter-format workshops* on specific topics.

2) Summer Academies and Regional Academies were also offered within this strand. These were two-day programs for local administrators and other AMSP educators to learn about the latest AMSP work, and to participate in discussions about how to use what AMSP had to offer to make changes in their local settings.

Contributions

Broadly speaking, the summer programs—especially the subject-matter intensive institutes—functioned as a vital "engine" of reform in the AMSP, serving as the major vehicle for district involvement, and the primary context for classroom teachers to gain access to enhanced disciplinary and pedagogical content knowledge. The Institutes and Academies made a number of specific contributions at the teacher, district and overall AMSP levels.

- Institutes served as a core mechanism for participation in the AMSP:
  - Given districts' familiarity with sending teachers to summer workshops, the AMSP Summer Institutes served as an effective entry point for districts to access the larger work of the AMSP.
  - For many districts, having teachers attend Summer Institutes served as the main vehicle for participating in the project.

- The Institutes were of high quality and value for teachers:
  - The Summer Institutes in both mathematics and science incorporated an inquiry-based approach that encouraged teachers to re-consider their pedagogical practices.
  - The Summer Institutes provided a level of professional development that many participating teachers had never before experienced; it is likely to be among the things they remember most about the AMSP long after the grant is over. Teachers were interested in having more opportunities like that, and wanted to encourage their colleagues to experience the same.
  - The AMSP's internal evaluators' pre- and post-institute data, collected at some Institute sites, suggested that teachers gained content knowledge from the Institutes.

- Investments in school-year follow-up added to Institutes' effectiveness:
  - Mentored interns were a complementary strategy that indicated to districts the AMSP's level of commitment and seriousness of purpose.
  - Participants in the Summer Institutes received generous stipends as well as classroom sets of materials to support their use of what they have learned.

- The Institutes expanded leaders' and participants' professional communities:
  - The Summer Institutes have provided opportunities for collaboration across institutions, across disciplines and across grade-level bands.
  - Teachers especially appreciated the opportunity to interact with IHE faculty members and teachers from districts other than their own during Summer Institutes.

- Institutes and Academies served as a vehicle for AMSP development:
  - Summer and Regional Academies provided a context for K-12 participants to learn more about the AMSP *and* for AMSP leaders to learn more about the needs of their K-12 partners.

This two-way information exchange helped shape the design and prioritize AMSP work over time.
  - In some more remote districts, Institute participants became the key district contacts for Regional Coordinators seeking to promote broader participation.

Challenges

The AMSP faced some challenges to optimal implementation of Institutes as a core mechanism for reform.

- Achieving equitable access to Summer Institutes was a challenge requiring changes in strategy:
  - Only the more motivated teachers tended to self-select for two-week summer commitments. Some of the teachers that AMSP has most wanted to attract and that district leaders have most wanted to send to Summer Institutes ultimately refused to give up two weeks of their summer break. The original format thus had limited reach for the full teaching population, and the AMSP responded with new formats.
  - With the exception of offering priority to Baseline Improvement Sites, enrollment in the Summer Institutes started out as first-come, first-served. Districts located closer to IHEs or with greater interest in reform tended to sign up more quickly than others. AMSP leaders needed to change their strategies in later years to reach more remote and less motivated districts.

- Program quality or follow-through for implementation was sometimes less than optimal:
  - With different facilitators leading Summer Institutes in different venues, issues of consistency and quality arose across different versions of the same offering.
  - Teachers deeply appreciated the classroom materials that they received as part of the Summer Institute; however, teachers did not always receive enough supplies for full-classroom use.
  - When it worked, teachers found the follow-up mentoring very valuable; however, logistical issues, especially time and geographic distance, were often a barrier to establishing strong mentoring relationships.
  - A mismatch between the technology used in Summer Institutes and that available in participating AMSP schools and districts sometimes made it difficult for teachers to implement what they had learned in their local setting.

- Cross-institutional collaboration was difficult to sustain:

- Despite the very best intentions, it has been difficult for IHE faculty to maintain ongoing contact with teachers with whom they have worked so closely, even though both parties express interest in doing so.

Lessons Learned

- The importance of adapting and evolving over time in response to local needs: The Summer Institutes were highly effective as an initial core reform strategy; at the same time, getting ever higher returns on this investment required new programs and adaptations as the AMSP evolved over five years:
  - The Summer Institutes, a significant investment of AMSP funds, yielded powerful returns in the form of teacher knowledge and district access.
  - AMSP leaders initially intended to offer each Summer Institute topic only once, but there was interest in much more. Multiple offerings increased the return on investment.
  - The PEP grants that began mid-way through the grant period helped further the impact of the Summer Institute strategy by providing: a) opportunities for deeper work in districts that were ready, and b) better introductory work in remote areas that had not yet experienced AMSP professional development.
  - Partner districts and counties responded well to modifications of the Summer Institutes (shorter sessions, more locations) designed to attract a wider range of AMSP K-12 participants.

- Taking care not to widen the technology gap between IHEs and K12:
  - While teachers and district leaders said they valued the exposure to new educational technologies, they also see that the technological capacities of the IHEs that offered the programs easily outstrip their own. Integrating technologies into instructional reform introduces more complexity into the challenge of implementation.

School Improvement and Program Enhancement

The work of this strand most directly involved and impacted the fifty-one partner districts at the organization level. This strand, the most diverse and customized in its design, involved the following:

1) *Regional Coordinators* played the key role in carrying out the work of this strand by connecting districts to AMSP programs and working with them to develop context-specific plans.

2) *Baseline Improvement Sites (BIS),* whose participation included *Program Improvement Reviews (PIRs)*, described above.

3) *Partnership Enhancement Program (PEP*) mini-grants that funded district-designed involvement in AMSP programs. Regional Coordinators and others also offered support for writing PEP grants to increase access to lower-capacity districts.[17]

4) *Parent Education* programs

5) *Site-based workshops* supporting implementation, including *Leading By Design, Using Data, Getting Results, Success for Seniors,* and *College Reality Store.*

6) *Outreach Professors* (IHE faculty) who served as liaisons between IHEs and school districts for a number of AMSP programs.

Contributions

- Increasing access and broadening participation at the organization level:
  - Regional Coordinators have been persistent in their efforts to make connections to more remote counties, often going beyond the designated AMSP contact to find a "catalyst" educator in the district that they can work with. In some cases, that person has been a teacher who attended a Summer Institute.
  - The PEP strategy, as noted above, provided districts with technical supports and resources enabling local reform participation to move beyond the individual teacher level.

- Generating a variety of programs that produce benefits for different targeted groups:
  - Through collaboration with the Prichard Committee (a Kentucky citizens advocacy group for education), the AMSP developed a *parent program* that interested districts chose to implement.
  - "College Reality Stores" helped *high school students and their families* to learn more about the college admissions process

[17] For more information, see the *AMSP Close-Up* pieces on Regional Coordinators, Baseline Improvement Sites, and the Partnership Enhancement Program.

and local opportunities they might want to take advantage of.
    - A small group of *K-12 principals* has learned to use handheld technology that supports their making classroom observations with greater frequency and regularity. Some of the *Leadership Interns* have also learned to use this technology.

Challenges

- Some districts became very deep pockets of work, while in others, the effort is quite thin: Even with the Regional Coordinators strategy in place, challenges remained that limited access to AMSP resources:
    - Throughout the initiative, the Regional Coordinators continued to encounter a handful of districts that were difficult to fully engage in the work of the AMSP.
    - Even with the Regional Coordinator position in place, much AMSP work with K-12 partners took place on an "on-call" basis, creating advantages for districts that are geographically closer to IHEs, that have personnel available for grant writing and other support, or that are simply more savvy about tapping into resources.

- Limits on the variety and availability of strategies that could serve the range of needs: Even though the AMSP created several effective means of participation, there were still limits to leadership and other resources:
    - The AMSP never developed a mechanism beyond the Regional Coordinators and Outreach Professors to connect interested IHE faculty members with districts that might benefit from their help and support.
    - A significant minority of districts experienced offerings such as *Success for Seniors* and *Using Data, Getting Results*. However, these were discontinued in the later years of the AMSP, not so much because of lack of need, but because of Regional Coordinators being asked to focus their attention elsewhere.

Lessons Learned

- Leadership that can span multiple institutions and levels: The success of the Regional Coordinators strategy produced important lessons for the AMSP and others:
    - In a partnership of this size and scope (in terms of geographic spread and the number of institutions), there need to be effective *mid-level leaders* connecting the central entity and the remote partners.

  - Leadership needs to *promote multi-way connections* to strengthen both the umbrella and the local micro-investments.
  - There need to be *enough mid-level leaders to provide individual attention* and customized support to localities. For the AMSP, three were too few and four were sufficient.
  - That leadership needs to be *well selected and well supported* if the umbrella partnership is to function.

- Growing local capacity for reform: District capacity to participate in reform grew from investment in local leadership development and in local teacher involvement in Institutes:
  - We observed a pattern of deepening district capacity for reform work that began with sending teachers to Summer Institutes and selecting a Baseline Improvement Site, followed by participating in the Program Improvement Review process, and then writing a PEP to address the needs surfaced in the PIR.
  - The AMSP strategically cultivated local leadership, which in turn facilitated connections between districts and their affiliated Regional Coordinators. This strand, more than any other, made use of the existing ARSI Teacher Partners as a resource for expertise and leadership.

- Strategic attention to equity and access: There are ever-present dynamics that, even with clear intentions and strategies, can threaten equity and access:
  - Sometimes the AMSP dropped activities simply because of stretched capacity arising from new program development. This was the case with offerings such as *Using Data, Getting Results* and *Success for Seniors*—programs that K-12 partners found very helpful in the early years but were not maintained with the onset of the PIR and PEP strategies.
  - A "first-come, first-served" strategy nearly always yields strong initial participation by those with highest capacity; this can help a program "get off to a good start." However, that strategy also always produces serious problems of equity and access. Especially with short-term investments of three to five years, a first-come, first-served strategy often results in lower-capacity districts barely getting started before the grant runs out.

Research

This strand of investment, originally much smaller than the others, grew slowly but deliberately over the course of the AMSP initiative, with its strongest work taking place in the final years of the effort. Key

milestones in the development of this strand included the hiring of a professor from the College of Education to direct the strand when it was identified, the designation of a Research Advisory Council, the articulation of an AMSP research agenda, and the commitment of Project Director John Yopp to use project data—particularly through needs assessment—to inform management decisions and strategic planning.

The Research strand eventually involved three types of activity:

1) *The internal evaluation*, which focused on data collection related to school improvement needs and project outcomes. This area of work was strengthened considerably in Year 3 with the hiring of a Data Manager and continued to improve in Years 4 and 5 under the leadership of the new Project Director .
2) *The external evaluation* by Inverness Research, which collected field-based data and provided assistance for formative purposes in Years 1-4 and documentation throughout the effort. To a limited extent, the Inverness Research team has coordinated its work with that of the AMSP's internal research group.
3) *A grant program that funded local research projects* by faculty at IHE partner institutions, aimed at producing knowledge about particular reform strategies for AMSP and the field. Faculty members could apply for grants of up to $50,000 to study questions related to the characteristics of effective partnerships, factors influencing rural students' career choices in science and math, contributors to students' and teachers' conceptual understanding of content, effective classroom strategies in math and science, and the effect of state and federal policy on Appalachian math and science education.

Contributions

- Promoting an orientation towards data-informed reform work:
    - The AMSP dedicated substantial resources to creating its comprehensive information management system. This investment demonstrated AMSP's commitment to collecting data and valuing evidence as fundamental to improvement.
    - The system has potential for ongoing use in the region as well as in other places.
    - Participating AMSP districts and IHEs have experienced the value of collecting needs assessment data and engaging in a process of data-driven decision making.
    - Other regional educational organizations, such as the Kentucky Department of Education, have adopted the AMSP's evidence-based processes leading to potentially long-term impact in the region.

- Faculty research grants emerged as a reform strategy with multiple benefits:
    - The AMSP Research strand has succeeded in putting out an RFP and funding a collection of independent research projects grounded in the work of the initiative. The successful implementation of this strand—which is difficult but advantageous for IHE and K-12 partnerships—represents a project accomplishment.
    - Researchers have shared findings at national MSP meetings, as well as national conferences, such as the NCTM Annual Meeting. This investment has thus made knowledge available to the field.
    - AMSP-funded research projects, such as two at UK's College of Education, promote new inter-departmental partnerships at IHEs and generate prospects for future collaboration.

Challenges

- The ambitious vision for this work, and its complexity, did not match initial project capacities:
    - Although the AMSP now shepherds a growing body of research connected to the work of the initiative, the project's has only recently developed the capacity to successfully conduct its own research.
    - The project has amassed considerable amounts of data, some of which may never be fully analyzed.
    - Coordination between the internal and external evaluation was less developed than either group envisioned.

Lessons Learned

The development of a research, or knowledge-making, effort within the context of a large multi-institutional partnership represents a substantial innovation, and requires capacities beyond those needed to create more familiar program types, such as institutes and courses.

- Such an investment, like any innovation, requires a guiding vision, very strong leadership, and the development of appropriate tools and resources: The following examples shed light on this broader lesson:
    - The Data Manager appointment has enabled AMSP to make better use of the data that the project has collected through its data management system.
    - The hiring of a Project Director with a background in data and assessment led to new evidence-based strategies for the

project overall and helped to make Research & Evaluation a higher priority across the workings of the initiative.

- A set of tools or resources that support locally defined research conducted by local PIs, Leadership Mentors and IHE faculty would have contributed to the overall productivity of these strands. Such tools were developed in the later years as part of the PEP effort.
- Without an initial guiding vision, the Research Strand evolved toward a collection of individual projects than a coherent body of work.
- The AMSP's emerging mandate to fund local work and initiative has resulted in a growing knowledge base grounded in the process of needs assessment and data-driven design.

IV. REFLECTIONS ON THE AMSP AS AN INVESTMENT IN IMPROVEMENT INFRASTRUCTURE

In this section, we reflect more broadly on the AMSP's umbrella partnership as a model for large-scale, multi-institutional instructional efforts. First, we examine the core values and design principles that underlay the partnership, that shaped its work and, we believe, that contributed significantly to its ultimate success. We conclude by showing that, over five years of steady effort that built strategically on earlier work, the AMSP has established what amounts to a regional "improvement infrastructure" for mathematics and science.

Core Values and Design Principles

A collection of core values and design principles girded the work of the AMSP, and shaped many decisions that were made along the way. It is important to specify these values and principles, because they provided a particular foundation for activities that made them more effective than they might have been otherwise, and they created a connective tissue across elements of the partnership that might have been more disparate otherwise. Some of these are explicit principles that AMSP leaders and personnel referred to from the outset. Others are more tacit values that emerged as the work itself evolved. Still others are distinguishing qualities that we, as the external evaluation team identified that set the AMSP work apart from that of other reform efforts we have studied. All of them are apparent in multiple aspects of the AMSP work.

AMSP design principles

Early on, AMSP leaders aspired to the following principles, which reflect their knowledge of the regional landscape as well as lessons learned from prior reform work.

Ensuring the availability of multiple pathways and entry points

The AMSP has served a broad range of constituents, all operating in a variety of contexts, possessing different capacities and resources to contribute to and benefit from the work. Project leaders wisely recognized from the outset that a "one size fits all" approach would not succeed. In particular, ways of working with highly motivated districts close to the IHEs would not help the project reach smaller and more remote districts in far corners of rural Appalachia, where the AMSP wanted most to have an impact. Instead, project leaders designed numerous opportunities for districts, schools and K-16 educators to participate in the project, the intention being that if one offering did not appeal to a particular person or organization, another one would.

Viewing local needs and issues as a priority

Few projects aspire to the institutional and geographic breadth of the AMSP: more than 50 school districts and nearly a dozen institutions of higher education in three states which represent some of the poorest and most isolated rural counties in the United States. AMSP leaders understood that locally designed and initiated work has the strongest impact, particularly in rural settings. Rather than dictate a top-down approach that would likely be rejected when it reached the level of small-town schools and districts, the project has placed a premium on giving local educators an opportunity to articulate what they need, and to advise project leaders as to how AMSP resources might best be used to meet those needs. The notion that "everybody contributes and everybody benefits" gave authority to local voice and empowered local leadership, leading to improved leadership capacity across the region.

Promoting the use of high-quality curricular resources and tools

In its professional development offerings and new preservice courses, the AMSP often made use of NSF-funded curricula materials in math and science, as well as related technologies. As a result, a number of districts have elected to adopt new curricula programs and have turned to AMSP for implementation support.

Encouraging data-informed planning and decision-making

From investing in a state-of-the-art information management system project-wide, to conducting multiple needs assessment surveys of educators at all levels, to facilitating individual schools in Program Improvement Review processes, the AMSP has demonstrated a strong commitment to making data central to the work of improvement. This focus has enabled the project to address issues based on reported figures rather than assumptions. Efforts to collect this information have, at least to some extent, made participants feel that the AMSP is interested in their opinions and feedback. There is also some evidence in the field that this focus on data-informed processes has influenced districts and IHEs in multiple ways: making choices about curricular offerings, selecting instruction materials, collaborating with regional partners engaged in similar work, and successfully writing grants outside of AMSP.

AMSP principles have evolved throughout the life of the grant

As the work of the AMSP unfolded and the leaders gained more perspective on its reach and its quality, they applied additional principles to the development of the partnership. We detail these principles below.

Cultivating more equitable access and participation

Some county and district leaders in the region have strong ideas about how they would like to improve math and science education in their institutions; others have little or no experience in this area. Some districts have a nearby institution of higher education, while others are more than 100 miles from the nearest college. How does a project equitably distribute its finite resources under such conditions? While there are no guaranteed methods or easy answers, AMSP leaders worked consciously as the partnership evolved to adapt in ways that would reduce inequities, particularly when it came to accessing AMSP-developed programs and services.

Fostering personal and professional connections

Rural Appalachia is known for its relational culture; however, remote communities are typically professionally isolated. The AMSP has capitalized on both of these qualities by providing numerous mechanisms for teachers as well as higher education faculty to interact and collaborate. The project further recognized that real "institutional partnerships" start with connections and collaboration among committed persons, working at first as individuals with common interests and goals. Ultimately, the aim is to foster relationships that will help support and sustain the work in Appalachia beyond the life of the AMSP grant, while simultaneously helping math and science educators feel less isolated in their daily work.

Challenging social hierarchies within education

The professional relationships that the AMSP promotes can, at times, fly in the face of tradition in Appalachia. For example, in the region, people tend to make use of professional titles, meaning a school teacher would generally not call a college professor by his or her first name. However, in the AMSP, it is common practice for teachers to interact with higher education faculty on a first-name basis in multiple settings. The same idea applies to high school people working with elementary people on content-specific issues in mathematics and science. As a result, there are fewer professional barriers and more opportunities for authentic collaboration.

Additional design features identified through external evaluation

As the partnership evolved, we saw two other design features that contributed to the success of the AMSP. These distinguish the AMSP from some other projects we have studied.

Responsiveness and openness to mid-course change

Some educational improvement leaders write a proposal, obtain funding and implement the initiative without pausing to consider whether their proposed plan is actually functioning or whether it is meeting the needs of those they are trying to serve. The AMSP has never been one of those projects. Instead, project leaders have consciously and constantly made an effort to modify their course of action according to the realities of actually doing the work—even if this meant launching an entirely new strand mid-course. This openness to change and responsiveness to feedback is rare in a project of this scope and size. In the end, we see this as being the factor that most contributed to the overall success of the AMSP.

A focus on local leadership capacity

We know from prior research that work designed and embraced locally has the greatest likelihood of making a real impact in rural settings. AMSP quickly learned to embrace local leaders who had participated in earlier projects; they also provided a variety of opportunities for educators at all levels of the system—teachers, counselors, K-12 administrators, higher education faculty and administrators—to further develop their leadership skills with respect to improving K-16 math and science education. The end result is a broad and lasting increase in local leadership capacity for math and science improvement.

The Construction of a Regional "Improvement Infrastructure" for Mathematics and Science

At the time of the AMSP's funding, many educators familiar with its proposed work questioned whether such a large and potentially unwieldy initiative, targeting one of the most impoverished regions of the country, could have a significant impact. Now, five years later, it is clear that the AMSP strengthened local capacity during the funding period. Beyond that, the AMSP helped to construct a regional *improvement infrastructure* for mathematics and science education that can leave an enduring legacy throughout Appalachia.

By "infrastructure," we mean the many supportive elements that are needed to carry out work that needs to be done. Just as the movement of goods requires a highway infrastructure, and the dissemination of information

requires communication infrastructures, the education of students requires a strong and reliable education infrastructure. And by "improvement," we mean the ongoing effort to help the education system get better, and further, *to help the education system get better at getting better*. An "improvement infrastructure," then, comprises the many supportive elements that are needed for the ongoing work of improving the professional development of teachers, improving the development of leadership capacity, improving the development and implementation of curricula, and so on.

These are the key elements of the regional improvement infrastructure that are a legacy of the AMSP:

- A shared vision of high-quality math and science teaching and learning that is communicated broadly throughout the region.

- The establishment of PIMSER (the Partnership Institute for Math and Science Educational Reform) as a new "hub" organization for supporting the ongoing work of math and science improvement in the region. The presence of such an entity is vital to sustainability because it makes ongoing regional improvement "invest-able."

- A network of IHE institutions that have the common experience of implementing new and redesigned courses for the purposes of improving the preparation of K-12 math and science teachers.

- Stronger professional relationships among IHE faculty in the region, providing a whole new level of collective wisdom and professional support.

- Local-PIs at all participating IHEs who provide leadership for continuing the work of math and science improvement at their institutions.

- Regional Coordinator positions at four IHEs that help connect people and work across the region.

- Outreach Professors whose job it is to work directly with K-12 schools and districts.

- Working partnerships between K-12 school districts and IHE faculty for the purposes of math and science improvement.

- Local K-12 administrators who are more knowledgeable about math and science reform.

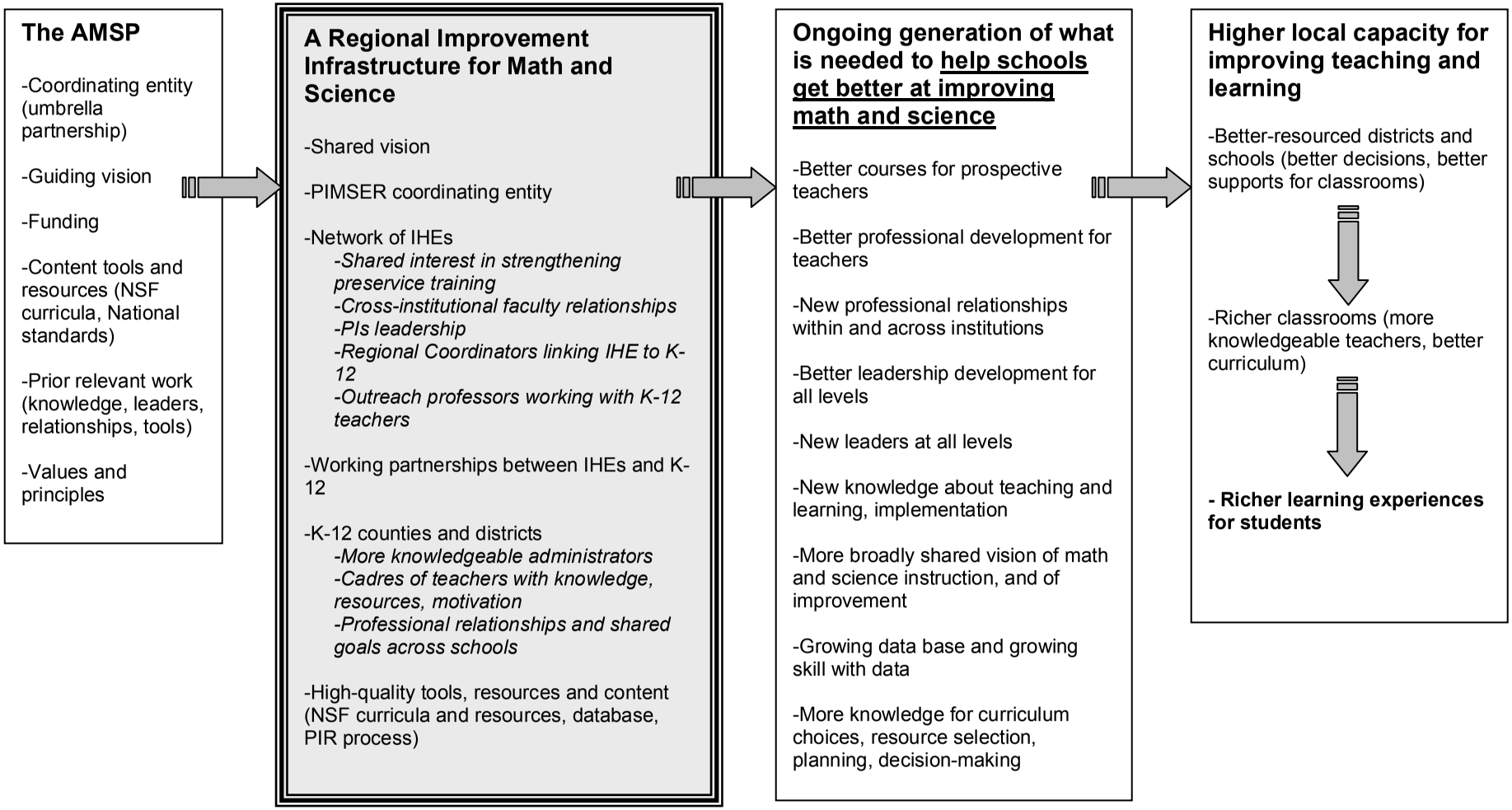
- Cadres of teachers at every grade level who have experienced intense, content-rich professional development and taken that knowledge back to their districts and schools.

- High-quality tools and content (data system, PIR process, NSF-funded curriculum) embedded in courses, workshops and district/school programs.

- Professional connections among teachers across districts based on a desire to implement similar improvements in math and science education.

The diagram on the following page portrays a conceptual model of this improvement infrastructure, showing it as a product of the investment in the AMSP, as a generator of resources needed for continual improvement, and ultimately as a contributor to better education for students.

Building a Regional Improvement Infrastructure



A Final Reflection

The AMSP received its funding in 2002, the same year that President George W. Bush signed the *No Child Left Behind* Act into law. In fact, the MSPs were originally designed to be a federal investment strategy that would provide support for actualizing NCLB goals across the country, with the funds shared between the Department of Education and the National Science Foundation. As NCLB was being implemented, generating strong responses and equally strong controversies, the AMSP was evolving as a large-scale partnership in one of the neediest, and thus most challenging, regions in the nation. It is fruitful to reflect on the accomplishments and lessons from the AMSP in that context.

The umbrella partnership as an organizing strategy

Well before any of us began using the term "umbrella partnership," AMSP leaders were trying to implement a different kind of partnership, one in which each member *contributed to* the work, and each member *benefited from* the work, an idea promoted by the National Science Foundation. It is especially notable that the AMSP did not become one large, top-down partnership—with the University of Kentucky leading the way. Project leaders understood from the outset that they needed deliberately not to default to such an arrangement, particularly with the UK serving as fiscal agent for the NSF's investment of more than $20 million dollars over five years. In order for such a partnership to grow authentically, the project leaders understood that any work the AMSP undertook needed to simultaneously be locally useful and appropriate as well as targeting and helping to accomplish the larger AMSP goals. The AMSP thus organized itself so that local leaders could design their own participation and projects, within the context of overarching AMSP guidelines, and receive their own funding. Over time, the umbrella partnership became an entity in and of itself. As the work evolved, the partnership was no longer the different members but the AMSP itself.

The importance of communication

The four strands of investment served effectively to conceptualize and organize the key dimensions of reform work sponsored by the AMSP umbrella partnership. The partnership as a whole, however, consistently struggled with the challenge of creating a reliable and effective communication system. The project's distributed leadership structure, fairly autonomous strands of work, and reliance on "the usual" communication processes and relationships within the regional culture meant that there were limits on information sharing, and thus on access and participation. The lesson to be learned from the AMSP experience is that, within an umbrella partnership of this scope and complexity, the deliberate creation of communication systems should be identified as an important and

independent cross-cutting strand of work that is integral to the success of the overall effort.

Valuing local voice

NCLB placed primary emphasis on increasing student achievement and secondary but also strong emphasis on teacher quality. These mandates created especially harsh policy conditions for states such as those in Appalachia, which have modest educational funding to devote to school improvement, a history of lower test scores (and thus greater pressure to improve quickly), and higher numbers of small rural schools, where many teachers teach multiple subjects and are thus more often "under-qualified" by NCLB standards. An effect of NCLB in this context has been a dramatic reduction in the valuing of local expertise and practitioner knowledge, and the creation of a top-down culture of education reform.

The AMSP, however, took a decidedly different stand by seeking out, honoring, and cultivating local voice. From the outset, AMSP leaders understood that any lasting reform effort would need to be thoroughly embraced by the small local communities in which the project was attempting to motivate change. Their assumption that a top-down approach would not take root in the mountains of Appalachia was a welcome change for educators caught in the eddies of the NCLB-driven culture that has defined improvement efforts in recent years.

We believe the AMSP was onto something. People responded when they felt heard and respected and, as a result, we can see the landscape of math and science improvement in Appalachia changing. We have encountered reports of educators at all levels of the system bring able to articulate a more clear and increasingly shared vision of what constitutes high-quality instruction in math and science. Even higher education faculty, historically most entrenched in their ways and the least likely to change, have indicated that they are applying AMSP principles to their courses and seeing a difference. In addition, the initiative has made significant contributions to the quantity and quality of inservice as well as access to research-based instructional materials available across the region. Through the AMSP counties and institutions, there is evidence of increased improvement capacities, including: new leadership, new structures, new curricula, and K-16 connections that did not exist in the same way prior to AMSP. We suggest that these are the features of an education landscape that create greater potential for positive change in teaching and learning.

The need for steady investment over time, rather than short-term episodic funding

Harnessing these new capacities and maintaining momentum is certainly possible, given the building of the improvement infrastructure we describe above. However, some level of ongoing steady investment in that

improvement infrastructure—beyond normal education operations—is needed to continue the course of math and science improvement in Appalachia well beyond the NSF funding period. Taking into account what we learned from the AMSP, which builds on what we have observed in Appalachia over more than ten years' time, we can see that the building of capacity for improvement takes time and steady effort—thus ongoing dedicated investment—beyond that of the normal operation of schools.

Clearly, there is greater capacity in Appalachia to improve mathematics and science education now than before the AMSP. And the AMSP came on the heels of, and built upon, earlier NSF projects that had built some capacities in some areas. Our examination of progress made in Appalachia, though, suggests that making large episodic investments for short periods of time is not optimal as a strategy for investing in improvement. It may be wiser to make somewhat smaller investments over a much longer time-frame, so that as local partnerships take hold on different time trajectories, and as regional leadership capacities grow, local partners can continue to be part of an infrastructure always dedicated to their ongoing improvement.

Appendix A

NSF-Funded Projects in Appalachia Prior to or Active During the AMSP

Project	Award Number	Amount*	Grade	Content Focus	Location	IHE Role
CATS – Coordinated and Thematic Science (Teacher Enhancement) 1995-1999	NSF-9454425	$4,252,105	Middle/ Secondary (Gr. 7-10)	Science	WV (statewide)	Content specialists, initiative leaders, PD providers
ARSI – Appalachian Rural Systemic Initiative 2000-2006	NSF-0086188	$10,822,306	K-14	Science, Math & Technology (science focus)	KY, OH, WV, VA, TN, and NC (limited to counties with a poverty rate of 30+%)	Hosted regional Resource Collaboratives
West Virginia – Handle on Science (LSC) 1998-2004	NSF-9731412	$1,866,620	Elementary/ Middle K-6	Science	WV (5 counties in northern panhandle)	PIs, PD providers and recipients, housed materials resource center
MERIT – Mathematics Education Reform Initiative for Teachers 2000-2005	NSF-9911928	$5,861,995	Middle	Math	West Virginia	PD providers and recipients, initiative leaders
ASSET – Academic Success for Students and Educators Together: Restructuring K-8 Science in Southwest Virginia (LSC) 1999-2004	NSF-9819562	$1,932,000	Elementary	Science	Southwest Virginia	Content specialists, PIs, PD recipients, housed materials resource center
ACCLAIM – Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics (CLT) 2001-2006	NSF-0119679	$9,995,830	Higher Education/ Math Education	Mathematics and Mathematics Education	Kentucky, Ohio, Tennessee	PIs, Co-PIs, Instructors, Dissertation Advisors
South Fork LSC – South Fork Local Systemic Change Pilot Project 2001-2003	NSF-0101910	$199,999	Elementary	Science	Tennessee	Content specialists
Coalfield RSI – Coalfield Rural Systemic Initiative: Building Bridges to the Future 2002-2007	NSF-0135822	$4,500,000	K-12	Math and Science	VA & WV (18 counties)	Partners and PD providers

*According to data provided at http://www.nsf.gov

NOTE: The table above provides details about the projects with which AMSP attempted to directly collaborate through its conference in the fall of Year 2. Other projects that operated prior to and during the AMSP effort include: West Virginia Reach Out (Local Systemic Change pilot project), Coal in the Heart of Appalachia (Undergraduate Science in West Virginia), the ARSI Master Teacher, PRISM (the Kentucky State Systemic Initiative), the Middle Grades Math Teacher Network (a Teacher Enhancement initiative in Kentucky) and Discovery (the Ohio State Systemic Initiative).

Appendix B

AMSP Research Activities Conducted by Inverness Research

- Interviews with project PIs, management team members, regional coordinators
- Observation of PI and Advisory planning meetings/retreats
- Participation in Executive Team meetings
- Participant-observations of summer institutes for teachers
- Interviews with participating teachers, faculty members and facilitators involved in multiple levels of summer institutes
- Interviews and focus groups with university faculty involved in the design and delivery of AMSP courses
- Site visits to all IHEs
- Site visits to selected K-12 districts and their associated Baseline Improvement Sites
- Reviews of key program documents, such as the Program Enhancement Program (PEP) request for proposals, Program Improvement Review tools, and Research and Evaluation request for proposals
- Collaboration with AMSP internal evaluation team
- Participation in PEP review process
- Interviews with PEP recipients