Appalachian Rural Systemic Initiative

Year 8 Progress Report
# Table of Contents

**Introduction** ................................................................................................................................ 4

I. **Overview of the Appalachian Rural Systemic Initiative (ARSI)** ………………4-9

   A. The ARSI Model ........................................................................................................ 4
   
   B. Demographics and Current Status of the ARSI Project ................................. 5
   
   C. Professional Development ............................................................................... 6

II. **Evidence of Systemic Reform** .................................................................................. 9-19

    A. Driver 1: Standards Based Curriculum ............................................................... 9
    
    B. Driver 2: Policy Changes .................................................................................... 10
    
    C. Driver 3: Resource Convergence ..................................................................... 10
    
    D. Driver 4: Partnerships ....................................................................................... 12
    
    E. Driver 5: Student Achievement ......................................................................... 13
    
    F. Driver 6: Student Equity Issues ........................................................................... 17

III. **Status of the ARSI Supplemental Projects** .............................................................. 19

IV. **Lessons Learned and Remaining Challenges** ............................................................ 21

V. **ARSI Program Focus Initiated in Year 8 to Be Continued Through Years 9-10** ........................................................................................................ 23

**Summary** ................................................................................................................................... 24
YEAR 8 PROGRESS REPORT

Figures

1. ARSI School Demographics........................................................................................................6
2. Amount of Time Teacher Partners Spent on Various Activities..............................................7
3. Number of Teachers Receiving PD Through ARSI Activities................................................8
4. Curriculum Implementation in Schools Participating for 3 Years or More.........................9
5. Source and Amount of District Funds for Mathematics and Science..............................11
6. Funds Generated by the ARSI Project ..................................................................................12
7. Student Performance Data for Ohio Participating School Districts.................................15
8. Student Performance Data for West Virginia Participating School Districts....................15
9. Student Performance Data for Kentucky Participating School Districts.........................16
10. Student Performance Data for Virginia Participating School Districts..........................16
11. Student Performance Data for Tennessee Participating School Districts......................17
12. Comparison of Male and Female Mathematics Enrollment and Performance ..............18
13. Comparison of Male and Female Science Enrollment and Performance....................19
INTRODUCTION

The Appalachian Rural Systemic Initiative (ARSI), one of four original NSF Rural Systemic Initiatives, continues to make a major impact on the region. At the outset of the project, ARSI committed itself to “closing the achievement gap” between the isolated and poverty-laden school districts in Appalachia and wealthier, more advantaged regions of the states served. Eight years later, the participating districts’ student achievement data indicate that ARSI has been successful in this venture.

The contributions of ARSI to the school reform efforts of the Appalachian region have been significant and are detailed in this report. In general, ARSI has impacted the following strategic aspects of school reform:

- ARSI school districts across the Appalachian region have developed a “vision of quality mathematics and science programs” which has provided direction for reform efforts.
- School and district policies have been developed that promote excellence in science and mathematics.
- Financial resources for science and mathematics have been significantly improved.
- Participating school districts now have a system-wide curriculum in science and mathematics aligned with state and national standards.
- Professional development is now based on comprehensive, school-wide assessment and related to program needs in the content areas.
- Emphasis has been placed on improving teacher skills in their content areas or the specific pedagogy necessary to improve student performance.
- Support from parents and the community at large has increased dramatically as schools made significant efforts to improve parent and/or community engagement.
- School leaders in the region have been prepared to lead the kinds of reforms needed to meet the state and national expectations in today’s “results oriented” environment.

The ARSI project has accepted the tremendous challenges of working in a high poverty region by developing a model which is built upon the expertise and strengths of the local communities, while, at the same time, elevates their goals and expectations through the implementation of standards-based programs and consistent training and support for teachers and school leaders.

I. OVERVIEW OF THE APPALACHIAN RURAL SYSTEMIC INITIATIVE

A. The ARSI Model

The ARSI Approach. The success of the ARSI model lies in its regional delivery system and its capacity-building strategies. The ARSI-eligible counties are spread throughout Kentucky, Ohio, West Virginia, North Carolina, Tennessee and Virginia. Having completed its eighth year of operation, ARSI has built on significant performance gains and has overcome many of the challenges it first faced when working with the rural Appalachian school districts in these states. Keys to ARSI’s success include the utilization of:

- Teacher Partners to build district capacity for improving mathematics and science,
- Resource Collaboratives to establish a broad-based system which facilitates local planning and decision making,
• Leadership Teams consisting of Teacher Partner, ARSI District Liaison, Superintendent, and a Principal to develop a district plan that supports program improvement,
• Program Improvement Reviews that help schools assess their current mathematics and science programs upon which to base their plan for improvement, and,
• Resource convergence for student learning through partnerships with Departments of Education, Appalachian Technology & Education Consortium, Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics, and the Appalachian Mathematics and Science Partnership.

**Resource Collaboratives.** The five Resource Collaboratives strategically located at area universities, spearhead ARSI’s reform efforts. As “field agents”, the Collaboratives facilitate local planning and decision-making while coordinating training for Teacher Partners and direct services to catalyst schools in their region. ARSI’s goal is to embed the functions of the Resource Collaborative within each university so that these sites will continue as centers for science and mathematics education reform beyond the scope of NSF support.

**Teacher Partners.** ARSI has developed a strong network of committed and competent Teacher Partners in participating districts. Teacher Partners have become the primary change agents for reform. In catalyst schools and other schools in their districts, Teacher Partners help other teachers implement standards-based instruction and provide support for curriculum development and selection of resources.

**Professional Development.** The primary strategy for change in schools in the region has been the professional development of mathematics and science teachers. Teachers in area schools now demonstrate attitudes that are consistent with standards-based mathematics and science and more frequently use standards-based practices, inquiry and problem solving.

**Community Partnerships.** Support for ARSI’s vision of high-quality, standards-based programs is widespread and improving steadily among stakeholder groups in the participating districts. ARSI Teacher Partners are active in building community support, which is enhancing understanding and involvement of school math and science programs. Activities that have helped schools reach out to the community include community meetings, family mathematics/science/technology nights, and the use of community, business leaders and parents on community engagement teams.

**ARSI Leadership Teams.** ARSI has consistently utilized a *team approach* to school reform. The district team consists of the ARSI District Liaison, Teacher Partner, school principals, and the district superintendent. District teams are supported by ARSI Resource Collaboratives located at five universities in the Appalachian region.

**B. Demographics and Current Status of the ARSI Project**

Sixty-six rural school districts, based on the level of children residing in poverty, were eligible for the Appalachian Rural Systemic Initiative at the outset of the project in 1996. During the academic year 2002-2003, ARSI had active participation in 36 counties and, during the course of the project, has had some level of involvement in 46 eligible counties in the six-state ARSI
region. The school demographics showing the total number of schools, students, and racial distribution is shown in Figure 1.

During Year 8, ARSI provided services to 252 schools in 49 school districts. 36 districts had one or more Teacher Partners for a total of 29 Teacher Partners released full or part-time for the provision of science and/or mathematics program improvement efforts. ARSI provided program development support for 18 school districts which together had a total of 15 affiliate Teacher Partners. The non-duplicated count of teachers served by the project indicates that 1,987 teachers received direct services from either the ARSI Teacher Partner or ARSI Resource Collaboratives. Teacher Partner and Resource Collaborative logs indicate that more than 47,293 hours of professional service development were provided during Year 8, which would be the equivalent of 7,882 training days. The potential impact on students due to ARSI’s involvement in Central Appalachia is extensive. Considering that each educator has direct contact with at least 25 students, the total number of students impacted by ARSI would exceed 49,000.

**Figure 1. ARSI school demographics including student racial distribution (from Core Data collected 2002)**

<table>
<thead>
<tr>
<th>Region</th>
<th>Total Number of Schools</th>
<th>Total Number of Math Teachers</th>
<th>Total Number of Science Teachers</th>
<th>Total Number of Students</th>
<th>Estimated Student Racial Distribution (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Students White</td>
</tr>
<tr>
<td>Elem.</td>
<td>167</td>
<td>1,885</td>
<td>1,825</td>
<td>42,988</td>
<td>42,018</td>
</tr>
<tr>
<td>Middle</td>
<td>35</td>
<td>160</td>
<td>134</td>
<td>10,465</td>
<td>10,229</td>
</tr>
<tr>
<td>High</td>
<td>85</td>
<td>284</td>
<td>259</td>
<td>28,234</td>
<td>27,597</td>
</tr>
<tr>
<td>Other (1)</td>
<td>52</td>
<td>347</td>
<td>322</td>
<td>10,881</td>
<td>10,635</td>
</tr>
<tr>
<td>Totals</td>
<td>339</td>
<td>2,676</td>
<td>2,540</td>
<td>92,568</td>
<td>97.7%</td>
</tr>
</tbody>
</table>

(1) “Unit schools” with a different grade distribution than normally configured as elementary, middle or high schools
(2) Based on racial percentage for all ARSI counties on the 2000 U.S. Census.

**C. Professional Development**

A primary vehicle for science and mathematics program reform in the ARSI districts is professional development. Driving this vehicle is the ARSI teacher partner, a highly skilled mathematics or science educator selected by the catalyst school. During the Phase I (first five years) of the project, teacher partners focused primarily on their own classroom and school (catalyst school). During Phase II, teacher partners are extending their efforts throughout the district.

The number of teacher partners has increased from 21 in the 1996-97 school year to 29 during the 2002-03 school year. Of this number, 16 were released on a full time basis. An important validation of the value of Teacher Partners to local district mathematics and science reform efforts is the fact that all teacher partners’ salaries were supported to some extent and 10 teacher partners’ salaries were supported entirely with local district funds. In addition, every district provided financial support for the teacher partners to attend ARSI professional development meetings. Resource Collaboratives have conducted monthly training sessions for
teacher partners as well as leadership training for principals and leadership teams focusing on mathematics and science program improvement. District liaison and superintendent meetings also helped insure a strong science and mathematics delivery system in ARSI schools.

The percentages of time that ARSI Teacher Partners worked in various mathematics or science program improvement activities are shown in the pie graph illustrated in Figure 3. These data indicate that 92% of the Teacher Partner’s time was spent in direct services supporting science and mathematics education reform.

A major focus of ARSI’s professional development during Year 8 has been to help schools know how to better utilize the collaborative inquiry process and data-analysis results for mathematics and science program improvement. This professional development has primarily used two resources: each school’s individual Program Improvement Review and Using Data/Getting Results: A Practical Guide for School Improvement in Mathematics and Science by Nancy Love. The emphasis on data analysis has facilitated both curriculum development and professional growth for teachers in ARSI schools. (See Section V for further explanation).

As a partner with the Appalachian Technology in Education Consortium (ATEC), ARSI teacher partners, other teachers, and Principal Partners participated in professional development that promoted the integration of technology into the mathematics and science curricula. Training on selecting high-quality research-based instructional materials, many of which were NSF developed has also continued. Reviews were done in the textbook adoption areas to help insure that materials are aligned with both state and national standards districts and resources are unified across the grade levels in the districts. Further training was provided to Teacher Partners using the Hands-On Virtual Physics Project which focuses on the topics light, heat and temperature. This training is designed to promote an increase in teacher content knowledge in Physics, as well as to provide classroom materials for the teachers to create physics lesions for their students.

ARSI partnered with the Appalachian Mathematics and Science Partnership to offer a series of mathematics and science workshops across the region. Five (5) Physical Science for Elementary Teachers, two (2) Geometry for Middle School Teachers, two (2) Communicating Mathematics,
and one (1) Science Models in Middle School Mathematics provided two week experiences for more than 200 teachers in Kentucky, Tennessee and Virginia. As a result of their participation, teachers received a stipend, travel expenses and the instructional materials necessary to teach the content learned in the workshops.

Other important professional development activities conducted by ARSI during Year 8 included the following:

- Research on best practice strategies and how they can impact student achievement using: *Classroom Instruction That Works* by Robert Marzano
- Content and Pedagogy in Mathematics using: *Elementary and Middle School Mathematics* by Van DeWalle
- Incorporating reading strategies in the science and mathematics classroom that can lead to increased student achievement
- Using Handhelds in the Mathematics and Science Classroom, a workshop designed to develop skill in using a handheld computer with probeware in mathematics and science instruction
- *Idiscovery* on-line mathematics and science professional development programs
- *Stuff that Works*, an NSF-funded initiative which helps teachers learn how to implement technology into the k-6 curriculum
- Use of *Improving Classroom Questions* by Kenneth R. Chuska to enhance Teacher Partner skills in the implementation of standards-based instructional practices.
- ARSI districts participated in the development and implementation of the Hands-on Virtual Physics Project, an innovative professional development initiative for middle school science teachers.

**Figure 3: Number of teachers receiving professional development through ARSI activities (2000-2002)**

<table>
<thead>
<tr>
<th>School level and subject</th>
<th>Total number of teachers employed during the school year</th>
<th>Number of teachers who received initiative-sponsored professional development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary school teachers</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4,393</td>
<td>3,864</td>
</tr>
<tr>
<td>Middle school mathematics teachers</td>
<td>170</td>
<td>183</td>
</tr>
<tr>
<td>High school mathematics teachers</td>
<td>283</td>
<td>379</td>
</tr>
<tr>
<td>Middle school science teachers</td>
<td>163</td>
<td>170</td>
</tr>
<tr>
<td>High school science teachers</td>
<td>254</td>
<td>307</td>
</tr>
<tr>
<td>Total</td>
<td>5,263</td>
<td>4,903</td>
</tr>
</tbody>
</table>

**Principal Training.** Principals in ARSI school districts are involved in the development and implementation of an innovative instructional program monitoring and improvement system,
Leadership by Design: Patterns of Instruction (LBD), which utilizes a Pocket PC/Website system for collecting and analyzing classroom observation data. The system has converted the current instructional management system, which collects classroom observations using a paper/pencil format and filing approach, to a state-of-the-art program using a hand-held computer/website based data collection system. The data collected provides the basis for an analysis of “patterns of instruction” which lead to higher student achievement in science and contribute to decisions regarding professional development and program improvement.

ARSI, in partnership with the ATEC and AMSP Projects and Kentucky Department of Education, has collaborated with a software developing firm, Hensley, Elam & Associates, to develop the web-based prototype and currently has 34 principals in five states participating in a beta test. The principals at the test sites have identified both programmatic and technical issues, and the system is now ready for broad-based training and distribution. Principals have received training in “what to look for in quality science classrooms,” use of the instrument and interpretation of data collected.

II. EVIDENCE OF SYSTEMIC REFORM

A: DRIVER 1: Standards-Based Curriculum

Since no participating school district had fully developed and aligned science and mathematics curricula at the outset of the ARSI project, the development and implementation of aligned, standards-based mathematics and science curricula has been a major focus of the project. Resource teachers have participated in curriculum development workshops and ARSI curriculum specialists have provided on-site technical assistance to participating districts. Because of ARSI’s efforts, over 80% of participating districts have now developed and implemented K-12 science or mathematics curricula aligned with their state’s standards for science and/or mathematics. Because of the emphasis on curriculum development and the identified need for resources to support the revised program, many ARSI school districts are also now selecting and purchasing resources consistent with national and state standards. Figure 4 shows the level of curriculum implementation for schools participating in ARSI for 4 or more years.

**Figure 4: Curriculum Implementation in Schools Participating for 3 Years or More: Appalachia (RSI) (2002 ARSI Core Data)**

<table>
<thead>
<tr>
<th>School Level</th>
<th>Schools participating in the SI for 3 years or more</th>
<th>Mathematics standards-based curriculum</th>
<th>Science standards-based curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of schools in which at least one-third of the teachers have implemented a standards-based curriculum</td>
<td>Percentage of schools in which at least one-third of the teachers have implemented a standards-based curriculum</td>
<td>Number of schools in which at least one-third of the teachers have implemented a standards-based curriculum</td>
</tr>
<tr>
<td>Elementary schools</td>
<td>30</td>
<td>28</td>
<td>93.3</td>
</tr>
<tr>
<td>Middle schools</td>
<td>11</td>
<td>9</td>
<td>81.8</td>
</tr>
<tr>
<td>High schools</td>
<td>10</td>
<td>9</td>
<td>90.0</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>46</td>
<td>90.1</td>
</tr>
</tbody>
</table>
Specific activities related to science and mathematics curriculum enhancement included:

- Teacher Partners led the development of science and mathematics curriculum implementation guides in West Virginia ARSI districts.
- All ARSI Ohio school districts have aligned their science and mathematics curricula to address state standards and benchmarks.
- ARSI districts in Tennessee have developed K-8 Benchmark activities in science; implemented inquiry based science and mathematics curricula; purchased kits to support elementary science instruction; and aligned curricula with the state’s newly implemented “Gateway Assessment Program.”
- In Virginia, ARSI districts have focused on upgrading teacher expertise in technology and the development of lesson plans incorporating new instructional strategies; teachers have been trained in the “Analysis of Student Work” strategies; focused on enhanced learning opportunities for students in geometry.
- Kentucky ARSI districts have incorporated standards-based resources such as Connected Mathematics and FOSS into the mathematics and science curricula.

B: DRIVER 2: Policy Changes

**Consistent Policies.** During the eight years of ARSI’s existence, the Resource Collaboratives have worked with the participating districts’ leadership teams in the development of school and district policies which increase mathematics and science learning opportunities for students. ARSI personnel have utilized enhanced state and national standards to leverage local policies and practices resulting in higher student achievement in mathematics and science. Examples of policies designed to increase the vigor and breadth of programs in ARSI districts are: “Requiring algebra as one of three courses in mathematics required for graduation” and “Increasing the number of science credits required for graduation.” All catalyst districts have implemented or revised policies to support mathematics and science programs since the outset of the ARSI project.

The types of *new* policies and numbers of ARSI school districts implementing them during Year Eight include:

- Increased number of science credits required for graduation (3)
- Increased number of mathematics credits required for graduation (4)
- Increased emphasis on inquiry based science and mathematics instruction (1)
- Increased requirements for successful completion of higher level mathematics or science courses (3)
- Increased resources for science and mathematics instruction (required expenditure of funds for manipulatives, kits, laboratory equipment) (8)
- Increased communication to parents regarding student achievement in science and mathematics (3)

C: DRIVER 3: Resource Convergence

**Convergence of Resources.** The districts participating in the ARSI project reside in some of the poorest school districts in the nation. In most cases, schools qualify for “school-wide” Title I assistance and generally have more children receiving free-lunch than not. Although, as would be expected, resources for science and mathematics instruction have been limited, ARSI has
coalesced existing significant available resources, services, and support for science and mathematics instruction. Local Title I, Title II, professional development, and Goals 2000 funds have been applied to ARSI mathematics and science program improvement efforts. Figure 5 represents the funding spent on science and mathematics reforms during Year 8 as reported by the ARSI participating districts.

These funds support professional development for mathematics and science teachers, as well as are used by participating schools for instructional materials and to support personnel to assist with mathematics and science program improvement. Much of the convergence of resources for mathematics and science is directly attributable to the efforts of the ARSI Resource Collaborative Coordinators who have assisted leadership teams develop stronger school and district improvement plans.

Figure 5. Source and amount of funds available for mathematics and science reform efforts in ARSI participating school districts (reported as part of Core Data).

<table>
<thead>
<tr>
<th>Source of Funds</th>
<th>2002-03 Funds</th>
<th>Total Amount Available to Support District-Level Science/Mathematics Activities</th>
<th>Total Amount Used to Directly Support ARSI Science/Mathematics Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate Funds</td>
<td>2,500</td>
<td>1,500</td>
<td></td>
</tr>
<tr>
<td>Eisenhower Elem. and Secondary Funds</td>
<td>853,778</td>
<td>150,134</td>
<td></td>
</tr>
<tr>
<td>Goals 2000 Funds (math/science only)</td>
<td>18,759</td>
<td>18,759</td>
<td></td>
</tr>
<tr>
<td>Foundation Grants</td>
<td>50,540</td>
<td>540</td>
<td></td>
</tr>
<tr>
<td>Other district funds</td>
<td>246,843</td>
<td>152,075</td>
<td></td>
</tr>
<tr>
<td>Other federal funds</td>
<td>98,103</td>
<td>47,199</td>
<td></td>
</tr>
<tr>
<td>Other funds</td>
<td>141,682</td>
<td>11,800</td>
<td></td>
</tr>
<tr>
<td>Other U.S. Department of Education funds</td>
<td>359,050</td>
<td>78,297</td>
<td></td>
</tr>
<tr>
<td>Perkins funds (math/science only)</td>
<td>57,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Title I funds (math/science only)</td>
<td>1,811,157</td>
<td>123,735</td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>3,639,412</strong></td>
<td><strong>584,039</strong></td>
<td></td>
</tr>
</tbody>
</table>

In addition to funds contributed by the participating school districts, ARSI has been successful in collaborating with regional agencies and has leveraged more than $7.3 million in additional resources for mathematics and science reforms in the region. The Appalachian Regional Commission, Annenberg Foundation, Eisenhower Regional Mathematics/Science Consortium at AEL, Ohio, Kentucky, and Tennessee Departments of Education are some of the partners which have provided additional funds for the ARSI project. Figure 6 shows the funds generated during 2002-03 and during the duration of the ARSI project.
**Figure 6.** Funds for mathematics and science reform generated as a result of ARSI collaborations with other agencies.

<table>
<thead>
<tr>
<th>Funding Source</th>
<th>2002-03</th>
<th>1996-2002</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annenburg Foundation Rural Challenge Program</td>
<td>0</td>
<td>759,000</td>
<td>759,000</td>
</tr>
<tr>
<td>Appalachian Regional Commission (ARC)</td>
<td>40,000</td>
<td>355,000</td>
<td>395,000</td>
</tr>
<tr>
<td>Ohio Department of Education</td>
<td>0</td>
<td>520,000</td>
<td>520,000</td>
</tr>
<tr>
<td>Eisenhower Regional Math/Science Consortium</td>
<td>0</td>
<td>80,000</td>
<td>80,000</td>
</tr>
<tr>
<td>State Higher Education Eisenhower Grants</td>
<td>50,000</td>
<td>682,737</td>
<td>732,737</td>
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<tr>
<td>Kentucky Department of Education</td>
<td>232,000</td>
<td>839,500</td>
<td>1,071,500</td>
</tr>
<tr>
<td>Goals 2000 Funds</td>
<td>0</td>
<td>950,000</td>
<td>950,000</td>
</tr>
<tr>
<td>Gear-Up Funds</td>
<td>467,200</td>
<td>904,400</td>
<td>1,371,600</td>
</tr>
<tr>
<td>Tennessee Department of Education</td>
<td>0</td>
<td>45,000</td>
<td>45,000</td>
</tr>
<tr>
<td>Other Mini-Grants</td>
<td>0</td>
<td>30,450</td>
<td>30,450</td>
</tr>
<tr>
<td>Appalachian Technology Education Consortium (ATEC)</td>
<td>78,483</td>
<td>172,131</td>
<td>246,614</td>
</tr>
<tr>
<td>Appalachian Collab. Ctr. for Learning, Assess. and Instruction in Mathematics</td>
<td>198,548</td>
<td>182,053</td>
<td>380,591</td>
</tr>
<tr>
<td>ARC and Kellogg Foundation (TN) in Appalachian Center for Higher Education</td>
<td>0</td>
<td>62,000</td>
<td>62,000</td>
</tr>
<tr>
<td>Whirpool Foundation</td>
<td>0</td>
<td>30,000</td>
<td>30,000</td>
</tr>
<tr>
<td>Vanderbilt University (TN)</td>
<td>0</td>
<td>10,000</td>
<td>10,000</td>
</tr>
<tr>
<td>Ohio Systemic Initiative-Discovery or Ohio Board of Regents</td>
<td>120,000</td>
<td>206,882</td>
<td>326,882</td>
</tr>
<tr>
<td>Appalachian Electric Power (AEP)</td>
<td>0</td>
<td>12,000</td>
<td>12,000</td>
</tr>
<tr>
<td>Appalachian Mathematics and Science Partnership</td>
<td>144,104</td>
<td>0</td>
<td>144,104</td>
</tr>
<tr>
<td>Improving Teacher Quality Grants</td>
<td>194,000</td>
<td>0</td>
<td>194,000</td>
</tr>
<tr>
<td>Dwight D. Eisenhower Professional Development Funds (Virginia)</td>
<td>58,247</td>
<td>0</td>
<td>58,247</td>
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<tr>
<td><strong>Totals</strong></td>
<td>1,582,582</td>
<td>5,841,153</td>
<td>7,423,735</td>
</tr>
</tbody>
</table>

**D: DRIVER 4: Partnerships**

**Stakeholder Engagement.** ARSI school districts have developed and implemented programs which increase parent and community involvement in the school program and increase science and mathematics learning opportunities for all students. Additional and more effective communication strategies have been implemented to better inform parents of student performance issues, mathematics/science/technology family nights provide parents and the community better insight into the instructional program, and parents, as well as community/business leaders have been recruited to serve on committees working to improve the instructional program.

**Higher Education Partnerships.** ARSI’s major partnerships are with the five institutions of higher education where the ARSI Resource Collaboratives (RC) are located. ARSI has made much progress in institutionalizing these “rural science and mathematics education centers” at each university site. These university relationships provide stability for long-term science and mathematics program support for the rural schools in Appalachia.

The Ohio ARSI Collaborative is incorporated into Ohio University’s (OU) College of Education (COE). In Virginia, the ARSI Resource Collaborative is a major component of and the operational model for the Center for Teaching Excellence at the University of Virginia’s College at Wise. Virginia school divisions have partnered with ARSI in providing funding to supplement the Eisenhower grant. The Resource Collaborative at the University of Kentucky is a part of the Appalachian Center, and the Tennessee Resource Collaborative is part of the University of Tennessee’s College of Education, Health and Human Sciences and is integrated with a U.S.
Department of Education Gear-Up grant and the Tennessee Appalachian Center for Higher Education funded by the Appalachian Regional Commission (ARC) and the Kellogg Foundation. The West Virginia Collaborative is integrated into the College of Education (COE) at Marshall University (MU).

These arrangements have provided an opportunity for collaboration in the development of grant proposals, involvement of rural science and mathematics teachers into the pre-service clinical and student teaching experiences, and enhanced professional development opportunities for rural educators. ARSI Resource Collaborative Coordinators have also assisted the universities by observing mathematics student teachers, teaching mathematics and science undergraduate methods courses and assisting in the development of courses that better reflect the national mathematics and science standards for teaching and learning.

**Other Funded Agency Partnerships.** During Year 8, ARSI staff collaborated in the implementation of the Appalachian Mathematics and Science Partnership project, which was funded at the beginning of Year 8. ARSI was also major partner with two other federally-funded projects, the Appalachian Technology Education Consortium (ATEC) and Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics (ACCLAIM). All three of these projects support and extend the ARSI goals for science, mathematics and technology reform in the Appalachian region.

The **Appalachian Technology in Education Consortium (ATEC)** is one of ten national Regional Technology in Education Consortiums funded by the U.S. Department of Education. ATEC serves schools in Virginia, West Virginia, Kentucky, and Tennessee by providing professional development, leadership support and technical services. ARSI is also including schools in Ohio and North Carolina in these support activities. The ATEC goal is to prepare teachers to integrate technology in a way that will deepen students’ learning and to prepare school administrators in strategies that will support this integration.

The **Appalachian Collaborative Center for Learning, Assessment and Instruction in Mathematics (ACCLAIM)** project is one of five National Science Foundation-funded Centers for Teaching and Learning. The four ARSI Resource Collaboratives at ACCLAIM-partner universities served as the primary vehicle for delivering professional development for improving mathematics teaching and learning opportunities through this project. During the five years of the project, ACCLAIM will provide nearly $1 million for extending ARSI’s professional development opportunities in mathematics as part of the overall commitment to “increase the capacity for mathematics teaching and learning” in the Central Appalachian region.

**State Departments of Education.** Partnerships and collaborations with each state’s Department of Education are supporting ARSI’s efforts to assist some of the lowest performing districts improve student achievement in mathematics and science. State Department of Education collaborations have also generated additional funding to support various aspects of the ARSI program, as reported in Figure 6.

**E: DRIVER 5: Student Achievement**

The ARSI project involves school districts in six central Appalachian states. Student achievement data has been presented by state to show the significant improvement in
participating schools (catalyst schools). A distinction has also been made between “high implementation” and “lower implementation” schools based on the level of implementation of the tenets of the “ARSI model” for reform.

**High-Implementation Districts.** Twenty (of forty) catalyst school districts, utilizing the “ARSI Model,” are rated as high-implementation, and exhibit the following characteristics:

- District and school-level leadership and vision that supports implementation of standards based mathematics and science;
- Highly-skilled Teacher Partner(s) who has provided leadership for school and/or district initiated science and mathematics program reforms including intensive professional development;
- Data-driven district and school-level improvement planning for mathematics and science program improvement efforts;
- Mathematics and science curricula aligned to state standards and sequenced across grade levels;
- Majority of teachers utilizing inquiry and/or problem-solving instructional strategies on a regular basis;
- Quality instructional materials aligned with the school’s science and mathematics curricula;
- Technology utilized in the mathematics and science instructional program and available to access resources supporting instruction; and,
- Professional development and leadership training based on both personal and school program improvement needs.

**Participating State Student Achievement Data**

Individual state student achievement data, based on scores achieved on each state’s assessment, provides a clear picture that ARSI is making a positive impact across the region. Comparison of ARSI school performance data to the performance of all schools in each state further illustrates that ARSI has “closed the gap” with schools in more affluent regions of each state. ARSI High Implementation schools consistently show greater improvements in performance than both the state and other participating schools.

**Ohio.** Data for Ohio ARSI schools at the outset of the project indicate that there was a significant achievement gap between ARSI schools and the percentage of students across Ohio, which meet the state standard in mathematics and science. After 7 years of ARSI participation, the gap for all ARSI schools has been eliminated and ARSI high implementation schools have more than doubled the number students in mathematics and science meeting the state standards. These data are represented in Figure 7.
**West Virginia.** Students in West Virginia are considered “proficient if they score above the 50th percentile on the SAT-9. To determine progress over time, the student assessment data for West Virginia has been aggregated to compare movement of K-12 students from the lower assessment quartiles to the 3rd and 4th quartiles. At the outset of the ARSI project, the participating schools were scoring below the state average in both mathematics and science. The 1997-2003 comparison data show steady and marked improvement in the number of students scoring in the upper percentiles and most important, the trend line would suggest that students in ARSI participating schools have “closed the gap” in both mathematics and science (state data not available for 2000-03). Figure 8 shows a comparison of the percentage of students scoring in the 3rd and 4th quartiles from 1997 to the results from the latest testing year (2003) for catalyst schools and the state.
Kentucky. The student assessment data for Kentucky has been aggregated to compare the performance of K-12 mathematics and science students performing at the “proficient” and “distinguished” levels on the Commonwealth Accountability Testing System assessment for ARSI participating schools and the state. The data presented in Figure 9 show that although all ARSI schools are still performing below the state average, Kentucky “high implementation” schools have a higher percentage of students scoring proficient or higher in mathematics than schools across the state. In science, the percentage of students scoring proficient or higher at both the state level and ARSI schools have increased dramatically since the outset of the project and, as with mathematics, ARSI high implementation schools are achieving higher than their state counterparts.

![KY Mathematics Results](image1)

![KY Science Results](image2)

Virginia. Standards of Learning (SOL) assessment data indicate that ARSI schools are performing at similar or higher levels than other schools across the Commonwealth. Virginia has a small number of ARSI school divisions and all are considered “High Implementation.” Figure 10 shows the Virginia student achievement trend lines.

![VA Mathematics Results](image3)

![VA Science Results](image4)
Tennessee. The data for Tennessee represents “district data” for the participating school districts. ARSI districts have consistently scored above state averages and the trend line indicates a widening performance gap between ARSI and non-ARSI school districts in mathematics. The Tennessee student performance data is shown in Figure 11.

F: DRIVER 6: Student Equity Issues

Student equity issues in the ARSI project tend to be centered on “gender” as the region’s demographic data indicates that less than 3% of the students represent a racial minority. Figure 12 compares the distribution of males and females in mathematics courses and indicates their relative performance in both higher and lower level courses. The data indicate that:

- The percent of females enrolled in lower level mathematics classes is consistently slightly higher than males.
- The trend in enrollment in lower level mathematics courses has shifted in 2003 with males gaining in enrollment percentage and nearly equal with females. Although females are still the majority in higher level mathematics courses, males made a slight increase in 2003.
- With the exception of calculus, the percent of females earning a “C” or higher in mathematics courses is higher than males.
- A significantly higher percentage of males taking calculus are earning a “C” or higher, returning to the trend observed in 2000 and 2001.
Figure 12. Male and Female Mathematics Course Enrollment and Achievement in ARSI Schools Based on Core Data in Participating School Districts in Six States.

<table>
<thead>
<tr>
<th>Enrollment/Achievement Data</th>
<th>2000 (N)</th>
<th>% Female</th>
<th>% Male</th>
<th>2001 (N)</th>
<th>% Female</th>
<th>% Male</th>
<th>2002 (N)</th>
<th>% Female</th>
<th>% Male</th>
<th>2003 (N)</th>
<th>% Female</th>
<th>% Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students Enrolled in Lower Level Math Courses</td>
<td>8655</td>
<td>53.1%</td>
<td>46.9%</td>
<td>9347</td>
<td>51.6%</td>
<td>48.4%</td>
<td>8984</td>
<td>51.3%</td>
<td>48.7%</td>
<td>6152</td>
<td>50.8%</td>
<td>49.2%</td>
</tr>
<tr>
<td>Students Enrolled in Higher Level Math Courses</td>
<td>4268</td>
<td>54.8%</td>
<td>45.2%</td>
<td>5275</td>
<td>56.7%</td>
<td>43.4%</td>
<td>5079</td>
<td>56.1%</td>
<td>43.9%</td>
<td>3068</td>
<td>55.4%</td>
<td>44.6%</td>
</tr>
<tr>
<td>Students Achieving a “C” or Higher on Lower Level Math Courses</td>
<td>4892</td>
<td>56.8%</td>
<td>43.2%</td>
<td>5599</td>
<td>55.7%</td>
<td>44.3%</td>
<td>6340</td>
<td>54.5%</td>
<td>45.5%</td>
<td>4294</td>
<td>55.2%</td>
<td>44.8%</td>
</tr>
<tr>
<td>Students Achieving a “C” or Higher on Higher Level Math Courses</td>
<td>2675</td>
<td>55.0%</td>
<td>45.0%</td>
<td>3750</td>
<td>58.8%</td>
<td>41.2%</td>
<td>4024</td>
<td>57.5%</td>
<td>42.5%</td>
<td>2417</td>
<td>57.3%</td>
<td>42.7%</td>
</tr>
<tr>
<td>Students Taking Calculus</td>
<td>285</td>
<td>48.1%</td>
<td>51.9%</td>
<td>286</td>
<td>48.6%</td>
<td>51.4%</td>
<td>234</td>
<td>52.9%</td>
<td>47.1%</td>
<td>151</td>
<td>43.0%</td>
<td>57.0%</td>
</tr>
<tr>
<td>Students Achieving a “C” or Higher in Calculus</td>
<td>237</td>
<td>47.7%</td>
<td>52.3%</td>
<td>236</td>
<td>47.5%</td>
<td>52.5%</td>
<td>222</td>
<td>55.4%</td>
<td>44.6%</td>
<td>142</td>
<td>44.4%</td>
<td>55.6%</td>
</tr>
</tbody>
</table>

Figure 13 compares the distribution of males and females in science classes and indicates their relative performance in both higher and lower level courses. The data indicate that:

- For the first time in a four year study, the percent of males enrolled in lower level science classes is higher than females.
- The percent of females enrolled in higher level science classes continues to be significantly higher than males, with the exception of physics, during the four years monitored.
- The percent of females earning a “C” or higher in all science courses is higher than males, however, the gender difference in percentage of students scoring a “C” or better in science has decreased.
- There is no clear gender difference trend line in student achievement in physics over the four years monitored.

The gender data for 2003 show positive enrollment trends for Appalachian males. ARSI school districts are examining student enrollment patterns, science and mathematics curricula, instructional methodologies, course taking patterns, and cultural factors which may be impeding the enrollment and successful completion of science and mathematics courses by males. The emphasis on examining school and district data is continuing in current ARSI professional development for both teachers and administrators.
Figure 13. Male and Female Science Course Enrollment and Achievement in ARSI Schools Based on Core Data in Participating School Districts in Six States.

<table>
<thead>
<tr>
<th>Enrollment/Achievement Data</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N)</td>
<td>% Female</td>
<td>% Male</td>
<td>(N)</td>
<td>% Female</td>
</tr>
<tr>
<td>Students Enrolled in Lower Level Science Courses</td>
<td>4548</td>
<td>51.4%</td>
<td>48.6%</td>
<td>5109</td>
</tr>
<tr>
<td>Students Enrolled in Higher Level Science Courses</td>
<td>3538</td>
<td>55.9%</td>
<td>44.1%</td>
<td>4391</td>
</tr>
<tr>
<td>Students Achieving a “C” or Higher on Lower Level Science Courses</td>
<td>2959</td>
<td>55.0%</td>
<td>45.0%</td>
<td>3254</td>
</tr>
<tr>
<td>Students Achieving a “C” or Higher on Higher Level Science Courses</td>
<td>2385</td>
<td>56.3%</td>
<td>43.7%</td>
<td>2972</td>
</tr>
<tr>
<td>Students Taking Physics</td>
<td>593</td>
<td>44.7%</td>
<td>55.3%</td>
<td>514</td>
</tr>
<tr>
<td>Students Achieving a “C” or Higher in Physics</td>
<td>433</td>
<td>41.8%</td>
<td>58.2%</td>
<td>420</td>
</tr>
</tbody>
</table>

III. STATUS OF THE ARSI SUPPLEMENTAL PROJECTS

ARSI Master Teacher Project

Overview

The ARSI Master Teacher Project is a three-year project to enhance regional leadership capacity for science and mathematics program reform in rural Appalachia and to provide intensive support in school districts that have ARSI Teacher Partners and are approaching full ARSI implementation. Having completed the second full year of the project, September 1, 2002 – August 31, 2003, the Master Teacher Program has made significant progress toward its two goals, building sustainable leadership for the region and providing support for long-term educational improvements in identified schools. Activities and accomplishments during the reporting period are summarized below.

The cadre of five “master teachers” who are referred to as “Regional Teacher Partners” (RTPs) was expanded to six during this year. Three of the RTPs have expertise in mathematics and three in science. They represent the range of elementary, middle, and secondary backgrounds. They have been released full-time from their districts through August, 2004. The RTPs have demonstrated characteristics needed for success in their role: vision clearly aligned with that promoted by ARSI; credible experience working with teachers and administrators on mathematics and science improvement; and a commitment to reflection on practice and ongoing professional growth. However, both they and project leaders recognized that they need ongoing development and support to enhance and extend their leadership knowledge and skills.

The project continued its activities from the previous year to support their growth as regional leaders, both through joint activities to build a common core of knowledge and skills, and through individual activities to address particular areas of interest and need for each RTP. The project made extensive use of the “study group” format for collaborative professional growth to
enhance their knowledge and skills as leaders of change. The Regional Teacher Partners learned together through reading, processing, interacting, and reflecting on important literature from the current knowledge base. Specific topics studied in depth included the following:

- Leadership and the skills of effective leaders
- Building leadership at the school level
- Using data for program improvement
- Innovative technology
- Research-based instructional strategies
- Addressing achievement gaps

Supporting School-Based Improvements in Mathematics and Science

The six RTPs began working with schools in the 2002-03 school year. They concentrated on working with a “focus school” in their home district; three also began working with a “focus school” in other districts in the ARSI region. The selection of schools to receive their services was made by the Master Teacher project director based on applications received. The schools committed to forming a Leadership Team, to releasing teachers one day a month to work with the RTP, and to provide at least three days for professional development in summer, 2003. These commitments ensured that the schools are serious in their intent to improve their mathematics or science program.

To date, the RTPs have provided concentrated assistance to 10 schools (7 in their home districts and 3 in other districts), impacting 36 elementary teachers, 71 middle and secondary mathematics and science teachers and 6,200 students. Notable accomplishments include:

- **Leadership Teams.** A key component of the project’s improvement model is the formation of a school-based leadership team, consisting of the RTP, principal, key mathematics and science teachers, a special education teacher, counselor, and a parent. In some cases a district administrator also sits on the team. The RTP helped the team articulate their vision and goals for the mathematics and/or science programs; examine pertinent data to identify program status and needs; and develop a plan for how to utilize the RTP in realizing their goals.

- **Data analysis.** RTPs worked with the leadership teams to use appropriate data to identify areas to target for improvement. The analysis included not only disaggregated state assessment data, but also information from ARSI Program Improvement Reviews, course enrollments, and other local sources. A wide variety of issues were surfaced through this process and the focus on data has helped the schools identify significant needs to address.

- **Mathematics and science cadres.** Each focus school has formed a “cadre” group of mathematics or science teachers. These teachers were released monthly to work with the RTP on improving curriculum, instruction, and assessment. The RTPs have provided professional development and ongoing discussion of issues such as inquiry teaching, questioning strategies, use of technology, assessment, and cross-curricular connections.

- **Curriculum enhancement.** Virtually all the focus schools have revamped some aspect of their mathematics or science curricula as a result of the RTP assistance. Several schools are working to implement standards-based instructional materials – two are using Connected Mathematics, one school is using TERC Investigations, and three are implementing science kits from FOSS, STC, etc.
• **Instructional support.** While the majority of RTP effort has been working with the leadership teams and cadres on program-level improvements, the RTPs also provided a limited amount of coaching to teachers seeking to improve specific aspects of their practice.

• **Student performance.** The RTPs have worked in their focus schools for only a year, so it is early to expect substantive changes in student performance directly attributable to their work. However, assessment data indicate that the schools are making improvements – seven of the ten focus schools posted improved scores on the state assessment from 2002 to 2003 in the subject area of the RTP work. The project will continue to monitor the student performance data for evidence of impact.

In addition to their work with their focus schools, the RTPs contributed to professional development in the ARSI region as well: regional workshops on the IMMEX modules; two 5-day regional academies focusing on inquiry; and 2-day regional workshops on the “Using Data, Getting Results” model of data analysis and collaborative inquiry.

**Status of the Noyce Scholarship Project: Supplement to the ARSI Project**

In an effort to sustain ARSI’s efforts of having highly-qualified teachers in the Appalachian region, ARSI submitted a proposal in May, 2002 for a Noyce Scholarship Supplement. ARSI was notified during the fall of 2002 that it was funded.

Through the Noyce Scholarship Supplement funds, ARSI is funding scholarships to juniors, seniors and graduate students who are pursuing science education certification (licensure) and agree to teach one year in a rural school district in Appalachia for each year that they receive a scholarship. Applicants are scored according to the following criteria: (1) academic qualifications, (2) member of under-represented populations, and (3) commitment to science teaching in a rural school environment. Higher priority is given to students who receive teaching certification in high-need science areas.

During the spring of 2002, ARSI worked with partnering universities on the process for selecting scholarship recipients, awarding scholarships, and monitoring compliance of scholarship requirements. Monitoring of the program includes both recipients’ successful pursuit of science teaching certification and graduates teaching the appropriate amount of time in approved school districts. Recruitment efforts include advertisement on the ARSI website, letters to community colleges, and information distributed to science majors who have not committed to a teaching career. The first Noyce Scholarship was awarded during Summer School 2003, and seven (7) scholarships were awarded during Fall Semester 2003. It is anticipated that the number of applicants will increase dramatically as students are identified at area community colleges and universities.

**IV. LESSONS LEARNED AND REMAINING CHALLENGES**

ARSI now has many assets in place in the region which were non-existent seven years ago. There is a network of committed and competent teacher leaders; administrators recognize program improvement needs and are willing to work with other school and district leaders to achieve higher performance in mathematics and science; Resource Collaboratives are now
strategically located at universities in the region and have established long-term and productive relationships with the ARSI districts; and, most importantly, the overall “capacity for reform” in the region has been greatly enhanced through the ARSI project.

Some of the “Lessons Learned” in past years, that have shaped the development of the ARSI Project during Year 8, include the following:

- **Understanding and use of data is critical to the success of school improvement efforts.** ARSI’S emphasis on understanding school and district data has been a major factor in both student achievement and student equity improvement. The emphasis of ARSI on “Using Data, Getting Results” during the remaining two years of the project will result in a “a legacy of school improvement” which will sustain the growth in mathematics and science achievement over time.

- **Knowledge of program improvement needs are critical to school district willingness to reform instructional programs.** Use of the Program Improvement Review as an assessment tool to determine the level of need and ability of school districts to embrace reform initiatives has proved to be invaluable to ARSI’s program improvement efforts. ARSI School districts develop individual improvement plans based both on need and capacity to implement the specific strategies available through the project.

- **District and school “Leadership Teams” are critical to successful program improvement efforts.** A common factor among “high implementation” school districts has been the presence of a “working team” of both teachers and administrators. Districts, in which there is a viable leadership team, have been able to sustain reform efforts and have shown more consistent improvement than districts in which leadership is dispersed or located in one or two individuals.

- **Efforts to increase community engagement must be integrated with other district mathematics and science education reform efforts to be effective.** Successful and sustained ARSI parent and community engagement activities have been fully integrated into reform efforts at both the school and district level.

- **Implementation of technology into the instructional program continues to be an area of need for all rural schools in the Appalachian region.** Teachers need much assistance in how to better utilize this tool on a regular basis in their classrooms. Technology can be successfully integrated in science and mathematics instruction leading to higher level student performance only if teachers have a clear understanding of the nature of scientific inquiry and mathematics problem solving and appropriate pedagogy for increasing student learning.

- **Administrative support is key to the change process.** School principals must be “brought on board” and kept informed if science and/or mathematics education reform is established and continued.
• It is critical that reform efforts be institutionalized so that the gains which have been made in improving science and mathematics instructional programs can be sustained over time. Isolated professional development for individual teachers will not sustain improved science and mathematics programs. ARSI has worked hard to “imbed” reform initiatives into area colleges and universities to provide a support system which will continue well beyond NSF funding for rural school initiatives.

V. ARSI PROGRAM FOCUS INITIATED IN YEAR 8 TO BE CONTINUED THROUGH YEARS 9-10

Using Data/Getting Results: An ARSI Program designed to build an instructional reform legacy throughout the Appalachian Region

The ARSI project has continuously focused on improving mathematics/science teaching and enhanced student learning in Appalachian School Districts through increased use of data to drive reform efforts. ARSI districts have aligned their curricula with National and State standards and meticulously analyzed state assessment data to identify weaknesses. Although this approach has been beneficial, the ARSI staff committed to expanding the knowledge base of strategies for analyzing data and adopted Nancy Love’s “Using Data, Getting Results” as a primary reform strategy for increasing both student achievement and program effectiveness. This program is a research-based and proven effective approach for helping school districts “dig deeper” into their data for the purpose of informing instruction. Scaffolding upon work done in the ARSI Summer Academies of 2002 and 2003, and framed within the context and demands of No Child Left Behind legislation, the ARSI Resource Collaboratives have developed long range strategic plans to enable ARSI districts to build their capacity to utilize these resources and processes.

Using Data /Getting Results provides a structure, resources and tools to help teachers and administrators use data well. The process outlined in Using Data / Getting Results goes beyond just looking at and analyzing data; it provides a mechanism, the collaborative inquiry process, for formulating a problem statement and creating an action plan based on what students really need and not on what teachers and administrators are “comfortable with.” Collaborative inquiry creates a balance between data driven decision making and data driven dialogue. Through collaborative inquiry, districts are able to create a learning community where ‘folks’ learn how to develop a supportive community to improve student learning. The process avoids “pointing the finger” and “laying blame,” as it promotes people working and communicating together to inform decision making. The tools and process provided expand the repertoire of data tools from only state test scores to the inclusion of classroom tests, interview data, observation data, personal data, and cultural data. This approach encourages teachers and administrators to look at trends, all sources of information and test data for the purpose of making informed decisions. If successfully implement, all relevant groups construct their understanding of important problems (done within a context of shared norms and values) focused on student learning.

ARSI’s goal is to train district teams on how to glean more information from the student and programmatic data they have which will enable them to go beyond a “superficial analysis” and “speculation” about why students are not achieving at higher levels. A series of team training workshops and a district support structure has been developed to build each ARSI school district’s capacity to use data effectively to improve student learning.
Working collaboratively, ARSI Regional Teacher Partners and Resource Collaborative Coordinators have constructed “Data Facilitator Institutes” which were implemented at the Kentucky, Virginia and West Virginia Resource Collaborative sites for teams from Ohio, Virginia, Kentucky, and West Virginia. An “individual district strategy” was employed by the Tennessee Resource Collaborative to implement the same strategy. The initial sessions utilized generic, criterion-reference testing data and focused on learning the processes and skills needed to explore the collaboratively inquiry model advocated by Nancy Love. Upon the completion of the initial training, participants were asked to expand and/or solidify their data teams and to return for additional experiences to continue learning the process and building their capacity by utilizing their own standardized test data. Additionally, the teams are provided experiences in utilizing other sources of data as well as digging deeper and deeper into the data to formulate problem statements.

The Using Data, Getting Results experiences prepare the participants to set the stage for more data driven conversations, more thorough analysis of existing data, and a greater ability to draw valid conclusions. These capacities build support for program improvement efforts and align priorities in both the school district and individual schools.

SUMMARY

The success of school districts participating in the ARSI project is clearly demonstrated in the data accumulated by the ARSI project staff during the past eight (8) years. Student learning opportunities in mathematics and science have been vastly improved in the highly impoverished central Appalachian region as a result of ARSI participating district initiatives and effort. The leadership and support provided by the ARSI Resource Collaboratives has been translated into legitimate reform of mathematics and science instructional programs through talented and dedicated ARSI Teacher Partners, Principals, and district office personnel throughout the Appalachian region.