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ABSTRACT

The Appalachian Rural Systemic Initiative (ARSI) is a collaborative mathematics, science, and technology education reform effort among six states in central Appalachia--Kentucky, North Carolina, Ohio, Tennessee, Virginia, and West Virginia. The project aims to stimulate sustainable systemic improvements in these subjects for K-12 students in a historically low-performing region. The ARSI model is based on a team approach to school reform. The district team consists of the ARSI district liaison, teacher-partner, school principals, and district superintendent. District teams are supported by ARSI resource collaboratives located at five universities in Appalachia. A key component of the model is the teacher-partner, a skilled science or mathematics teacher, selected by the school to provide leadership for reform efforts. Teacher-partners receive training from the resource collaboratives and are provided release time for mentoring other teachers, assisting with curriculum development, acquiring instructional resources, and generally providing leadership for program improvement. Catalyst schools are designed as incubator sites for implementation of standards-based practices and become models for other schools. The ARSI model employs a cyclic system beginning with identification and analysis of science and mathematics program needs followed by school and district planning, implementation of reform strategies, and evaluative feedback. Positive results during year 5 included leadership development, standards-based curriculum development, development of consistent policies, increased community engagement, professional development, and improved student achievement. (Contains 36 figures detailing improvements in these areas.) (TD)

Appalachian Rural Systemic Initiative

(ARSI)

Phase I, Year 5

Annual Report

2000

ARSI PROJECT OVERVIEW

The Appalachian Rural Systemic Initiative (ARSI) is a collaborative mathematics, science and technology education reform effort among six states in Central Appalachia – Kentucky, North Carolina, Ohio, Tennessee, Virginia, and West Virginia. The overarching goal of the project is to *stimulate sustainable systemic improvements in mathematics, science, and technology education for K-12 students* in a region in which achievement has historically lagged behind other regions of the participating states. ARSI has made great strides toward achieving this goal by assisting schools create effective teaching and learning environments, align curricula with state and national standards, converge resources from local, state, and federal sources, and develop strong community partnerships focusing on mathematics, science, and technology education.

The "ARSI Model" is based on 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. A key component of the model is the *Teacher Partner*, a skilled science or mathematics teacher, selected by the school to provide leadership for reform efforts. Teacher Partners are provided release time for mentoring other teachers, assisting with curriculum development, acquiring of instructional resources, and generally providing leadership for program improvement efforts. The Teacher Partners have received extensive training and support from the ARSI Resource Collaboratives and are now providing leadership for *district-wide* reforms in science, mathematics, and technology education. Catalyst schools are designed as "incubator sites" for implementation of standards-based practices and are used as *models* for other schools in the district and region. The "ARSI Systemic Change Model" employs a cyclic system beginning with identification and analysis of science and mathematics program needs followed by school and district action planning, implementation of reform strategies, and evaluative feedback.

The primary ARSI agents for support of district efforts are the ARSI Resource Collaboratives. Through the collaboratives, ARSI establishes a broad-based system that facilitates local planning and decision-making and creates collaborations that align vital processes and resources. The professional staff, the *Collaborative Coordinators,* serve as "field agents" for the ARSI project, providing direct services to districts as well as being responsible for identifying resources at the sponsoring universities and other state and regional agencies for professional development and technical assistance. ARSI continues to institutionalize the functions of the Resource Collaborative at each university so that these sites will continue as centers for science and mathematics education reform beyond the scope of NSF support.

ARSI has established a broad-based system that facilitates local planning and decision-making by allowing students, teachers, administrators, and community members equitable access to factors critical to achieving the vision of quality mathematics, science, and technology education.

As a result of ARSI's efforts during the first five years of the project, student achievement has increased in science and mathematics in the catalyst schools, new and consistent policies increasing the opportunities for and rigor of mathematics and science programs have been enacted, and broad-based support for science and mathematics education has been achieved. These systemic improvements will contribute to the long-range goal of the ARSI project, to prepare a more competitive workforce not bound by its geography.

I. THE ARSI MODEL

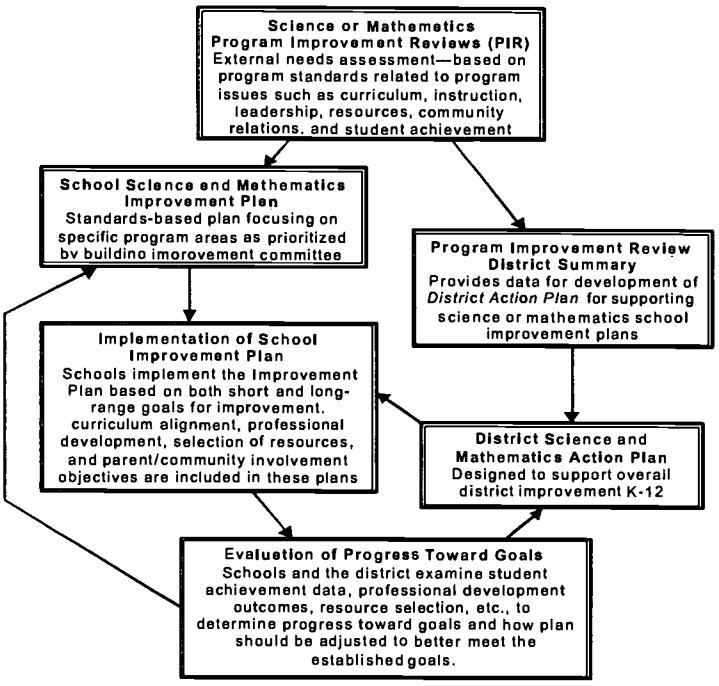
The principal goal of the Appalachian Rural Systemic Initiative continues to be *accelerating improvements in student performance in science, mathematics, and technology throughout the central Appalachian region.* ARSI has addressed three significant strategic goals during year 5:

- **Develop the knowledge and skills among K-12 teachers to create effective learning environments in which all students learn mathematics and science and use technology.**
- **Develop a sustainable system providing students and teachers with timely, coordinated access to educational resources and services that support active, standards-based teaching and learning.**
- **Develop the school leadership, regional partnerships, community involvement, and stakeholder support necessary to sustain long-term educational improvements.**

ARSI has demonstrated significant progress toward these goals during the tenure of the award.

Establishment of the ARSI "Systemic Change Model"

Figure 1



The ARSI model has evolved during the course of the project into a truly systemic and successful process for school and district reform in science and mathematics education. ARSI has come to fruition in Year Five, as many of the goals for increased local vision, enhanced capacity, and access to resources, services and support have been met. ARSI has capitalized on the resources, people and organizations in the region to develop vision, leadership, and commitment to school improvement.

The ARSI plan centered around establishing regional Resource Collaboratives to partner with participating schools and school districts to provide on-site outreach services. Early in the Project, it became apparent, that in order to impact district level improvement, there needed to be support at both the school and district levels. ARSI found that in districts successfully implementing reform strategies, it was necessary to have district-level leadership from the instructional supervisor and support from the district superintendent. It was also determined that the Teacher Partners' effectiveness also depended greatly upon support of the school principal and district administration. ARSI has continued the development of the District Leadership Team and provided training to assist these district teams implement reform strategies during Year 5.

Over the past two years, ARSI has made a major contribution in education reform in the central Appalachian region through the implementation of a its *systemic improvement* model. The ARSI Model has proved effective in providing both direction for school reform and a mechanism for technical assistance to catalyst schools. The model is based on a comprehensive review of each participating school's science and mathematics programs using the *Program Improvement Review (PIR)* process, development of short and long-range plans for program change based on the needs identified, and provision of leadership for working the plan through a local leadership team led by a highly skilled and well prepared *teacher partner.*

In addition to the structural components outlined, the model contains the following operational features: a) the *unit of change* is the school. Activities occur at the regional, district and classroom levels as well, but they are in support of the changes targeted in schools as a whole. b) While the structural components of the model are present in all participating districts, there is *flexibility* in how they are actually implemented. The specifics of how ARSI appears and operates in each school/district are guided by the realities of the local context. c) ARSI activities in a particular school/district are developmental and tailored to the readiness and ability of the local system to make systemic reforms. As the system develops in its capacity, commitment, and capabilities, ARSI's interactions with the system shift accordingly.

II. POSITIVE RESULTS ACROSS THE APPALACHIAN STATES SERVED BY ARSI

Pre-ARSI. At the outset of the project, the following conditions existed: School leaders generally lacked a "vision" of quality mathematics and science programs which could provide direction for reform efforts. None of the participating schools had a district-wide curriculum in science or mathematics aligned with their state or national standards. Few school or district policies existed that promoted excellence in science and mathematics. The financial resources needed to develop strong science and mathematics programs were limited and the funds that were available lacked coordination for the greatest student benefit. Support from parents and the larger community was lacking. Professional development was usually "district based" and focused on generic topics such as improving school discipline or improving student safety in schools. Most importantly, student achievement in the ARSI schools lagged well behind other schools in the region and the state. Although the school districts in Appalachia differ widely in their "readiness" and ability to participate in significant reform efforts, the districts exhibit commonalties that have provided direction for ARSI's work.

The following paragraphs summarize some of the positive aspects of ARSI during Year 5.

Leadership Development. During year five, ARSI has increased districts' abilities to understand better their own programs and the reality of science and mathematics instruction in their districts. As stated by ARSI's external reviewer, Inverness Research Associates, "*...we have consistently found that the most important element in determining the ultimate success of a reform effort is the presence or absence of skilled and committed leadership. There is no doubt that the greatest contribution of ARSI lies in this area: ARSI is helping districts identify, train and support local leaders who are knowledgeable about math and science reform and empowered to work towards change in schools and classrooms.*" (Appalachian Rural Systemic Initiative: Final Report, 2000) ARSI's efforts in training teacher partners, ARSI catalyst school principals, and central office administrators (ARSI district liaisons) have resulted in a district team that has provided extensive leadership for science and mathematics program reform efforts. The reforms have occurred primarily at *the school level,* however, and there is a need to build capacity at the *district level* therefore the leadership developed during ARSI Phase 1. Figure 2 shows the ratings of selected ARSI districts' "Current Status" and "ARSI Influence," from an on-site study conducted by Inverness Research Associates using a scale of 1-5 with a "5" representing 100%.

Figure 2--**District Capacity for Initiating and Sustaining Reform**

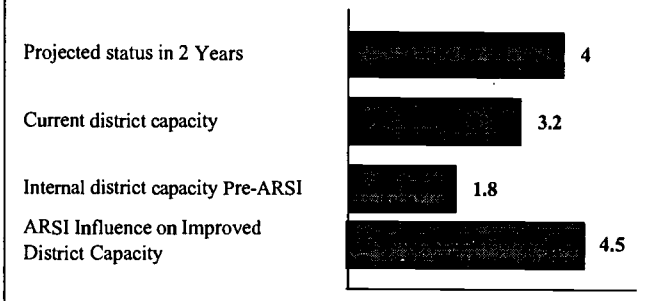
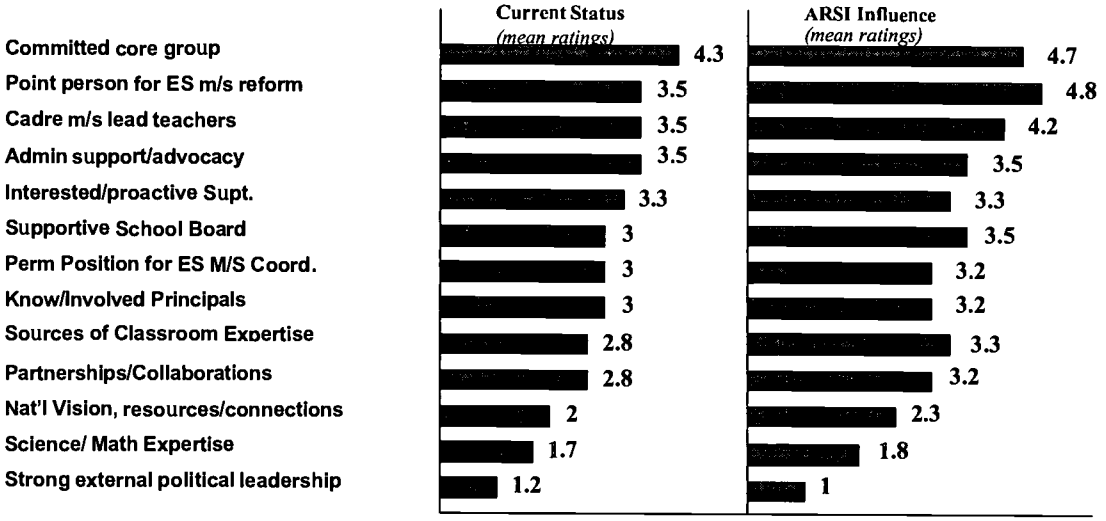


Figure 3 illustrates the ARSI external evaluator's assessment of the relationship between the level of "reform leadership" in ARSI school districts and the relative influence of ARSI activities on developing this leadership.

Figure 3 Leadership Capacity in ARSI Districts



RATINGS BASED ON FIVE POINT SCALES WHERE '1'='VERY LOW' & '5'='VERY HIGH'

Standards-based Curriculum Development. Since no school district had a fully developed and aligned curriculum 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, participating districts have now developed and implemented a K-12 curriculum 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 now selecting and purchasing resources consistent with national and state standards.

Consistent Policies. ARSI has worked with the participating districts' leadership teams in the development of school and district policies, which increase mathematics and science learning opportunities for students. 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.

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 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.

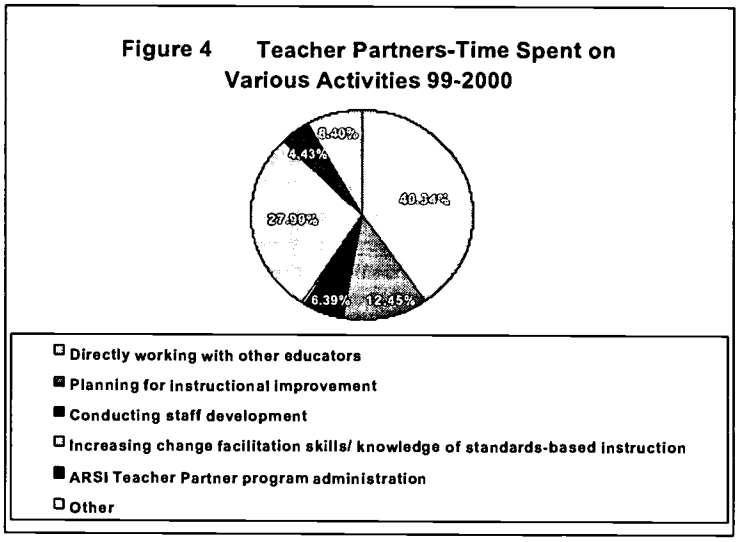
In addition, ARSI has been successful in collaborating with regional agencies and has leveraged an additional 3.4 million in resources into the region. The Appalachian Regional Commission, Annenberg Foundation, Eisenhower Regional Mathematics/Science Consortium at AEL, Ohio, Kentucky, and Tennessee Departments of Education are some of the partners which have provided additional funds for the ARSI project. Further verification of the value of the ARSI model to participating districts is the fact that 6 ARSI districts have placed teacher partners in additional schools *using local district funds* in excess of $150,000 during the 1999-2000 school year alone. The information provided in Section IV fully discusses the amount and types of external funding that has been reallocated by local districts through ARSI assistance to support improving mathematics and science education in ARSI Catalyst Districts.

Community Engagement. A major problem in most schools, and particularly rural schools in poor communities, is the level of parental and community support. Support for ARSI's vision of high-quality, standards-based mathematics is strong among stakeholder groups in the catalyst districts. ARSI community engagement teams include community and business leaders as well as parents as role groups. Community engagement teams are operating in 35 ARSI catalyst schools and districts. One fifth of the catalyst school principals reported increased business and community involvement and support during year five, primarily as a result of ARSI. Community involvement included family mathematics/science/ technology nights, community meetings to increase knowledge of science and mathematics instructional programs, assistance with student science and/or mathematics projects, community engagement teams, and community/school leadership teams.

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 first four years of the project, teacher partners focused primarily on their own classroom and school (catalyst school). During year five, teacher partners began to extend this effort throughout the district. The number of teacher partners has increased from 21 in the 1996-97 school year to 66 during the 1999-2000 school year. Of this number, eight were released on a full time basis. Local funds are used to pay for part of the release time for many teacher partners and **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 focusing on mathematics and science program improvement. District liaison and superintendent meetings held quarterly also helped insure a strong science and mathematics delivery system in ARSI schools.

The following graph shows the relative amount of each type of support provided by the ARSI Teacher Partners as reported on daily logs.

Figure 4 Teacher Partners-Time Spent on Various Activities 99-2000

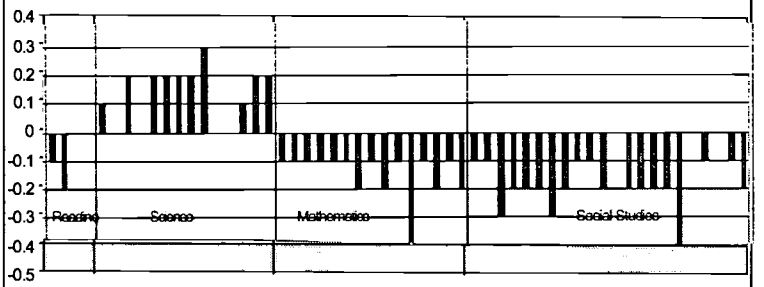


Improved Student Achievement. Student mathematics and science performance in catalyst schools is improving. Ninety-four percent of ARSI catalyst schools are showing improvements in state assessment results in mathematics, science, or both since beginning their involvement with ARSI. Analysis of trends in assessment results indicate that ARSI catalyst schools are improving relative to comparison schools in non-participating districts and that some gaps with state averages are narrowing.

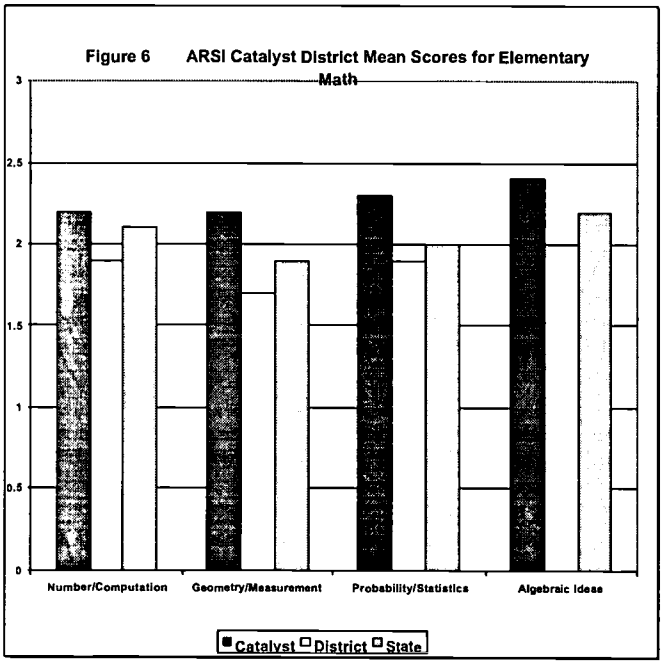
In examining individual school data, the results are even more dramatic. An ARSI school that has had a full range of interventions in science demonstrates the type of results achieved through the project. The data shown in Figure 5 are for a school in which the ARSI model has been fully implemented beginning with a *Science Program Improvement Review (PIR).* Based on findings of the *PIR,* ARSI interventions included the development and implementation of an aligned, standards-based curriculum and extensive staff development in inquiry-based instruction. Following the ARSI interventions, student achievement in science has increased significantly and exceeds the state average in all assessed areas whereas the student achievement in all other content areas, none of which had similar interventions, was below the state average.

Figure 5 Example of ARSI Middle School Showing Improvement After ARSI Involvement

DIFFERENCE FROM STATE MEAN



Assessment areas include Reading, Science, Math, and Social Studies, with only science showing improvement–the area where Program Improvement Reviews were conducted and extensive work was done by ARSI staff in assisting schools in implementation



The data in Figure 6 shows the performance of another ARSI school that is equally impressive. This ARSI school is nearing "full implementation" meaning that all ARSI standards are being addressed. This catalyst school has implemented an aligned, standards-based curriculum in mathematics and provided extensive problem solving instruction professional development for teachers through the ARSI teacher partner. As can be seen, the ARSI catalyst school scored above the district and state average in every mathematics sub-domain area.

These data are not unique. In addition to the aggregated regional data, assessment data for participating schools and districts from each of the six states participating in the ARSI project have been analyzed. The results indicate substantial improvement in nearly all ARSI schools since the inception of the ARSI project. A sample of elementary, middle, and high school assessment results from each of the participating states is included in results described fully in Section IV.

Core Data. In addition to the professional development activities of teacher partners, ARSI resource collaboratives brokered the services of university science and mathematics educators and other consultants to provide professional development for participating school districts. During Year 5, over 5,000 teachers, administrators, parents, and community members are more knowledgeable about standards-based instruction as a result of 123,420 participant hours of professional development provided by teacher partners in local districts. In addition, ARSI sponsored science and/or mathematics content and pedagogy professional development activities enabled 3,310 teachers and administrators to be better prepared to teach and support instruction.

In summary, although many barriers must still be overcome, ARSI has generated an enthusiasm for science and mathematics education reform through higher expectations for students, teachers, administrators, and the communities in general. ARSI districts have a new vision for and commitment to provide educational opportunities for all students which is being translated into higher achievement at all levels of instruction.

III. SUMMARY OF THE STATUS OF THE ARSI PROJECT AFTER 5 YEARS

ARSI has been assisting schools since the 1995-96 school year. Cohort I schools are those that have had involvement with ARSI since the 1996-97 school year. Cohort I Catalyst Schools are experiencing significant improvements in the status of mathematics and science education that include aligned curricula, standards-based instructional strategies, and inquiry-based student learning. This section provides information regarding the changes in mathematics and science programs in schools and identifies the districts' perception of how ARSI has influenced those changes.

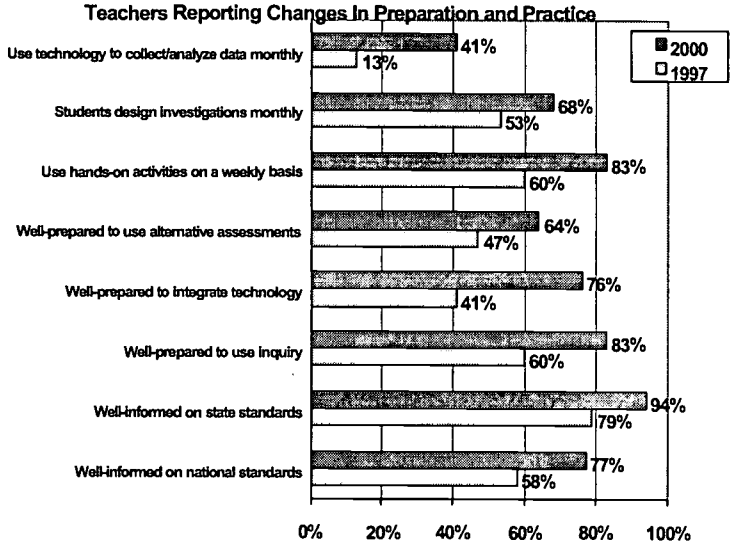
Questionnaire Results for ARSI Cohort I. Each year since 1997, mathematics and science teachers and administrators in ARSI districts have completed questionnaires about their attitudes, preparation, classroom practices, and program status. Analysis of Spring 2000 questionnaire results and their comparison to baseline results in 1997 provides the following information regarding ARSI Cohort I teachers, catalyst schools, and districts:

Catalyst Teachers report ARSI influence on teaching. Three-fourths of catalyst school teachers (and half of all the teachers) report that ARSI has influenced their mathematics and/or science teaching. Teachers who report being influenced by ARSI are significantly different from their colleagues, in that they:

- hold attitudes more consistent with standards-based approaches;
- are better-prepared to implement standards-based strategies;
- use standards-based strategies in their classrooms regularly.
- identify fewer barriers to implementing their math and science teaching
- have stronger attitudes consistent with standards-based math and science
- have higher level of preparation to use standards-based practices
- use technology more frequently in support of instruction

Catalyst school teachers indicate that they are better prepared to use the kinds of strategies envisioned by ARSI and by state and national standards, even though overall, implementation of standards-based strategies is still in its early stages in the catalyst schools. (Figure 7)

Figure 7– Percent of Cohort I Catalyst School Teachers Reporting Changes In Preparation and Practice

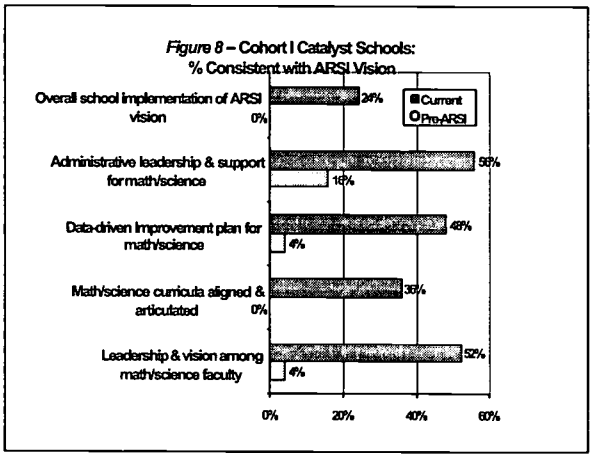


Schools report math/science program improvements. Since becoming involved with ARSI, Cohort I catalyst school teachers and administrators report improvements in the school's mathematics and science programs including:

- Better availability of curriculum materials aligned to standards.
- Better availability of professional development appropriate for mathematics and science teachers.
- Greater amount of funds allocated to mathematics and science.
- Better availability of local resource persons to support implementation.

Significant improvement is reported in preparation and practices. Specific questionnaire items with statistically significant improvement from 1997 to 2000 are included in Figure 8.

Figure 8 – Cohort I Catalyst Schools: % Consistent with ARSI Vision



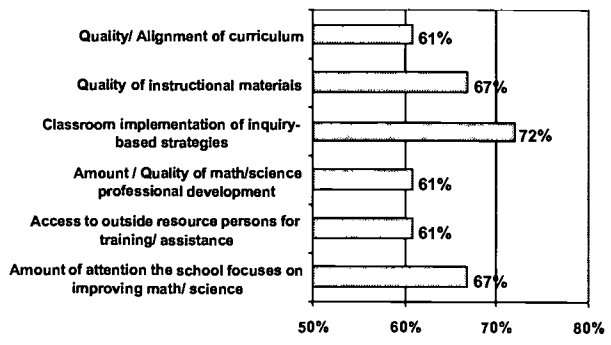
The percentage of Catalyst School Principals that report progress in their programs and attribute that progress to ARSI is shown in Figure 9.

Progress at the district level. During Year 5, ARSI influence and impact has extended beyond the Catalyst Schools. District Liaisons report numerous areas of their district-wide mathematics and science programs have been improved, including:

- Alignment of district mathematics and science curricula
- Quality of available instructional materials
- Availability of professional development for mathematics and science teachers
- District attention focused on mathematics and science

Figure 10 shows district-wide ARSI impact as reported by central office personnel.

Figure 9--% Cohort I Catalyst School principals Reporting Progress Attributed to ARSI

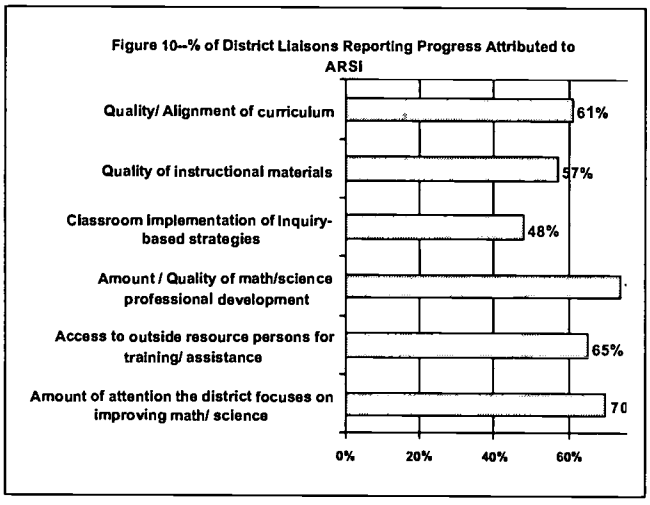


IV. ARSI RESULTS—YEAR 5

A. DRIVER 1: Implementation of Standards-Based Mathematics and Science

Catalyst Schools have shown a significant increase in the use of standards-based instructional strategies, use of technology, and the understanding and influence of national and state standards. Two-thirds of the Catalyst School mathematics and science teachers indicate that ARSI has influenced their teaching. Furthermore, those Catalyst School teachers who report ARSI influence have greater levels of: participation in math/science professional development; attitudes aligned with standards (particularly regarding inquiry-based teaching); and use of standards-based instructional strategies (e.g., hands-on activities, student-designed investigations, cooperative group work, portfolio entries, and using technology for data collection/analysis).

Figure 10--% of District Liaisons Reporting Progress Attributed to ARSI



As was noted in Section II, Catalyst Schools have made substantial improvements in their mathematics and science curricula, aligning them to state assessments and articulating them across grade levels. Improvements are also observed in the quality of available instructional materials and the degree of implementation of standards-based instruction.

Figure 11 shows *ARSI School/District Implementation Status* ratings for the catalyst schools, using a rubric developed by ARSI staff.

Figure 11. District Implementation Ratings	Standards-Based & Aligned Mathematics and science curricula		Use of Instructional Materials Aligned to curricula		Teachers implementing inquiry-based teaching practices	
	Pre-ARSI	1999	Pre-ARSI	1999	Pre-ARSI	1999
Percent of Districts	29%	79%	31%	86%	10%	75%

B. DRIVER 2: Supportive Policies

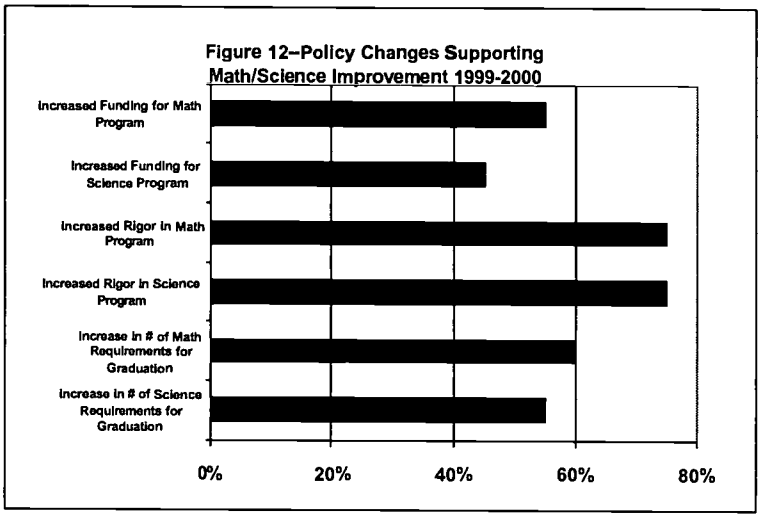
The six ARSI states have developed and adopted state standards, curriculum frameworks, and performance expectations that are based on and consistent with the national mathematics and science standards. The state standards and other requirements form a backdrop that significantly influences local policies and practices.

Feedback from catalyst school teachers and districts administrators indicates that the following changes in policies impacted the school's and district's mathematics/science programs:

- ***Policies and Procedures to Insure Strategic Planning.*** Over **three-fourths** of catalyst school principals attribute to ARSI policy changes that increase the amount of time for planning in their school and district focused on improving mathematics and science.

- ***Policies and Procedures Insuring Use of Student and School Data.*** Data-driven planning is a regular occurrence in Catalyst Schools. **Ninety-four percent** analyze state assessment results to identify program needs; 84% include specific priorities for mathematics and/or science in school improvement plans (only 38% report doing so prior to their ARSI involvement).
- ***Policies and Procedures Insuring Adequate Instructional Time.*** Catalyst schools are addressing issues of time in mathematics/science reform, based on Program Improvement Review recommendations.

Figure 12 indicates the types of policies and the percentages of participating ARSI disricts which have enacted each in support of the provision of higher quality mathematics and science programs.



C. DRIVER 3: Convergence of Resources

At the regional level, ARSI has been successful in collaborating with other entities to coordinate fiscal and human resources in support of standards-based mathematics and science and has brought over $3.4 million in additional resources into the region, including:

- $759,000 from the Annenberg Foundation Rural Challenge program supporting activities in ten (10) schools, nine (9) of which are in ARSI counties. Total funding will be over $1.1 million and involve 15 ARSI schools.
- $140,000 through the Appalachian Regional Commission (ARC) for technology implementation in 19 ARSI counties from private industry.
- $215,000 in federal ARC funds to support community engagement, technology, and ARSI Leadership Academy.
- $430,000 from the Ohio Department of Education to support the Resource Collaborative at Ohio University to serve the southeastern Appalachian region of the state.
- $80,000 from the Eisenhower Regional Math/Science Consortium at AEL for training support for teachers.
- $165,000 state higher education Eisenhower grants for professional development of mathematics and science teachers in Kentucky and Tennessee.
- $250,000 from the Kentucky Department of Education for Teacher Partners and mathematics/science resources and professional development in Kentucky.
- $950,000 from Goals 2000 funds for five ARSI school districts to improve mathematics and science programs.
- $350,000 in 1999-2000 GEAR-UP funds to Rockcastle County, Kentucky for middle schools.

At the local level, funding is still an issue for mathematics and science, but is not seen as a major problem impacting the programs. In 1999-2000, Catalyst School Principals and District Liaisons reported a greater diversity of funding sources supporting mathematics and science reform, compared to the previous year. Figure 13 represents the funding spent on science and math reform reported by participating local districts.

Figure 13--External Funding Available in ARSI Catalyst Districts 1999-2000

Type of Funding	Amount Directly Supporting District-Level ARSI Activities
Eisenhower Elementary and Secondary	$207,077
Eisenhower Higher Education Funds	$85,000
Other District Funds	$187,055
Other Funds	$184,873
Title I	$465,778
State Funds	$250,000
Perkins	$336
Goals 2000	$350,993
Other Federal Funds	$1,731,112
Corporate Funds	$0
Foundation Grants	$500
Title VI	$54,189

In addition to professional development for mathematics and science teachers, Catalyst Schools used these available funds for instructional materials and support personnel to assist with mathematics/science implementation. The convergence of resources for mathematics and science is attributable, at least in part, to the inclusion of mathematics and/or science in local improvement plans developed with ARSI assistance through the consolidated planning process.

D. DRIVER 4: Broad-Based Support

Support for ARSI's vision of high-quality, standards-based mathematics and science is widespread and strong among stakeholder groups in the catalyst districts. ARSI specifically includes community leaders, business leaders, and parents as role groups on Community Engagement teams, which currently are operating in 35 Catalyst Schools and Districts. One-fifth of Catalyst School principals report increased business and community involvement and support over the past year, and most attribute the increase to ARSI.

Districts are developing and implementing programs that involve communities in the support of standards-based mathematics and science through a variety of means including support for parents assisting students in science fair projects, community meetings to increase involvement in mathematics/science programs, and family mathematics/science/technology nights.

ARSI Teacher Partners are active in building community support for mathematics and science as well. The types of activities included in 1999-2000 were presentations to PTA (18%); family math/science programs (29%); alerting local media about math/science events and recognition (53%).

School and district administrators are key stakeholders for supporting mathematics/science implementation at the Catalyst Schools. A majority of teachers perceive that their administrators are knowledgeable about standards-based teaching and are very supportive of a hands-on approach to mathematics and science; in fact, the teachers rated administrative support as the greatest asset to the mathematics and science programs. For their part, both District Liaisons and Catalyst School Principals reported attitudes and perceptions closely aligned with standards-based teaching. The ARSI Summer Leadership Academy played a key role in building administrative support. Administrators participating in the Academy demonstrated increased knowledge and commitment for supporting mathematics/science reform. On the ARSI-developed implementation rubric, the percentage of Catalyst Schools with insufficient administrative knowledge and support decreased from 53% at the beginning of ARSI involvement to just 7% at the present time.

Higher Education Partnerships. ARSI's major partnerships are with the five institutions of higher education where the ARSI Resource Collaboratives are located. During Year 5, ARSI has made much progress in *institutionalizing* these "rural science and mathematics education centers" at each university site. The Ohio ARSI Collaborative is incorporated into the Regional Professional Development Center at Ohio University and the West Virginia Collaborative is now integrated into the College of Education at Marshall University. In Virginia, the ARSI Resource Collaborative is a major component of and the operational model for the new *Center for Teaching Excellence* at the University of Virginia's College at Wise. The Resource Collaborative at the University of Kentucky is now a part of the *Appalachian Center* and the Tennessee Resource Collabortive is in the process of becoming a University of Tennessee "Center" which will more fully integrate its activities with other College of Education school district outreach efforts. These relationships provide stability for long-term science and mathematics program support for the rural schools in Appalachia.

Regional Partnerships. ARSI continues to maintain linkages with a number of regional partners. These include: the Rural Schools and Community Trust (formerly the Annenberg Rural Challenge), the Appalachian Regional Commission, AEL, the Eisenhower Regional Consortium at AEL, Oak Ridge National Laboratory, Project CATS, Forward in the Fifth, and the North Central Regional Educational Laboratory.

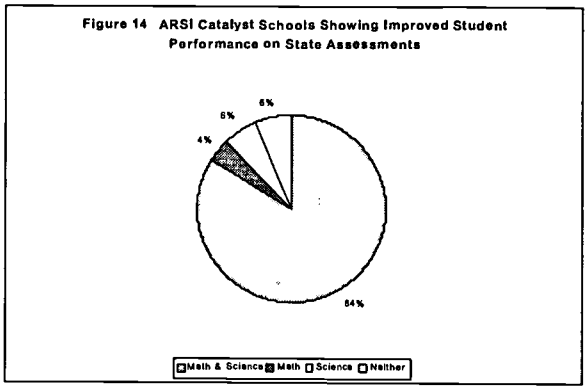
State Departments of Education. Partnerships and collaborations with each state's Department of Education are supporting ARSI's efforts to assist some of the lowest performing districts improve student achievement in mathematics and science. State Department of Education collaborations have also generated additional funding to support various aspects of the ARSI program, as reported in figure 15.

Other Collaborations. In addition to the instances cited above, collaboration and networking continue to be a means through which Resource Collaboratives provide additional workshop assistance to local schools. ARSI teachers receive training as a result of ARSI Resource Collaborative partnerships with state departments of education, the American Association for the Advancement of Science (AAAS), the National Nuclear Society, the Woodrow Wilson National Fellowship Program, North Carolina State University, Colorado School of Mines, National Science Teachers Association, and the Western Carolina University.

E. Driver 5: Student Performance

Determination of Regional Assessment Results. Because each of the six states in the ARSI region has its own standards and assessments, the project faces several challenges in meaningfully representing its impact on regional student performance. Particular challenges include aggregating assessment data across states and determining suitable comparison indicators. The method used to aggregate the six states' assessment data is described in Appendix A.

Figure 14 ARSI Catalyst Schools Showing Improved Student Performance on State Assessments



Aggregated Student Achievement Data. Student achievement data for ARSI districts validate the impact of the ARSI model. Figure 14 indicates that overall, as determined through an aggregation of individual state assessment data, 94% of all ARSI Catalyst Schools show improved student performance in either mathematics or science. 88% of the Catalyst Schools show improvement in science and 90% of the Catalyst Schools improved performance in mathematics. These data include all schools involved with the ARSI project regardless of the number of years in which a teacher partner has been working in the district or the level of implementation of the ARSI model. The method used to aggregate the six states' assessment data is described in Appendix C.

In examining student performance data based on the number of years of participation in the ARSI project, it is interesting to note that in Cohort One Catalyst Schools, on which there is data for three years, 91% of the schools show improvement in both science and mathematics whereas 9% of the schools show improvement in neither. (Figure 15)

Figure 15 ARSI Cohort 1 Catalyst Schools Showing Improved Student Performance on State Assessments

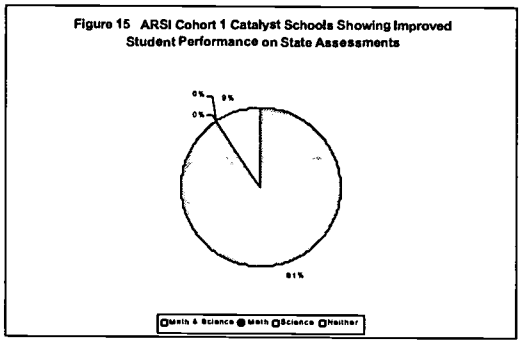
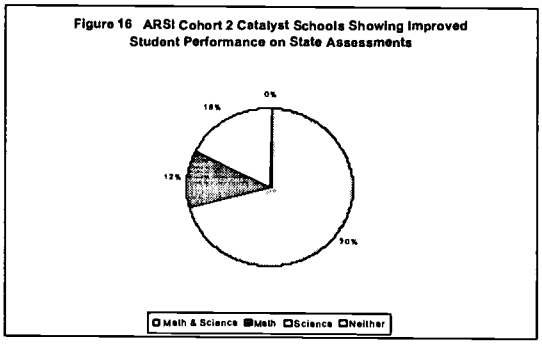


Figure 16 ARSI Cohort 2 Catalyst Schools Showing Improved Student Performance on State Assessments



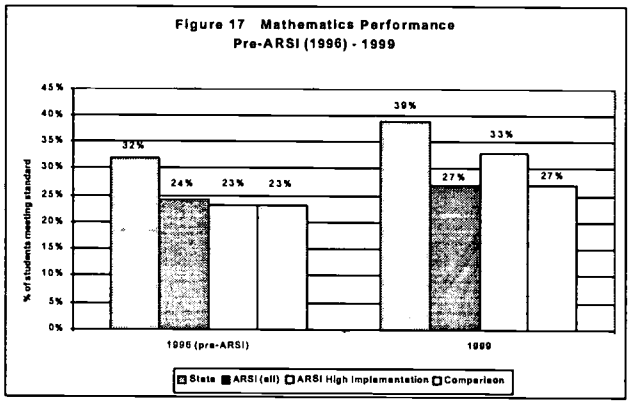
In Cohort Two Catalyst Schools, having had ARSI involvement for two years, 100% of the schools show improvement in either science or mathematics with 82% of the schools showing improvement in mathematics and 88% showing improvement in science. (Figure 16)

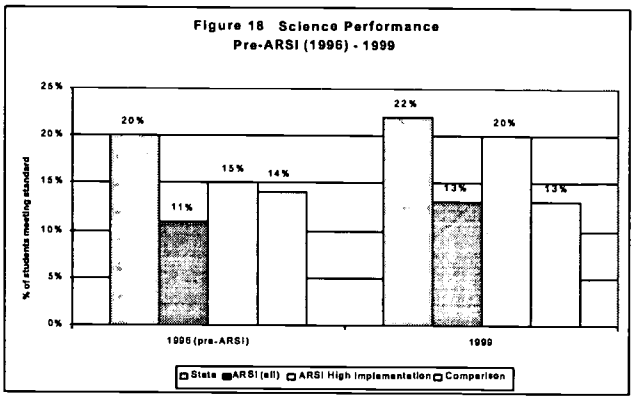
Twenty (20) of the forty (40) Catalyst Schools utilizing the "ARSI Model" are rated as "high implementation schools" and exhibit the following characteristics:

- District and school-level leadership and vision to support implementation of standards based mathematics and science;
- Highly skilled Teacher Partner who has provided leadership for school 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 utilize 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;
- Professional development and leadership training based on both personal and school program improvement needs.

The remaining twenty school districts are at various levels of implementation and exhibit some, but not all, of the characteristics identified above.

Overall, student achievement in both science and mathematics has improved during the five years of the ARSI project. A further analysis of the data, based on the level of implementation of the *ARSI Model*, indicates that ARSI Catalyst Schools nearing "full implementation," have significantly reduced the *gap* between their student achievement scores and state assessment scores. An even clearer indication of the impact of the ARSI project is the fact that the ARSI *high implementation schools* have improved at a much higher rate than comparison schools in the region. Figures 17 and 18 show aggregated student performance levels for science and mathematics in all Catalyst Schools as compared to the *high implementation Catalyst Schools*, aggregated state averages, and comparison school averages.





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. Figure 19 shows the improvement of student performance in selected catalyst schools from 1996 to 1999 in states served by ARSI. Data samples from each state have been provided to demonstrate the types of changes occurring.

Figure 19 Performance of Selected Catalyst Schools

% of students meeting state performance standard

Catalyst School/State	Subject	1996	1997	1998	199
Knott Co. High School/Kentucky	Math	13%	14%	17%	21%
Chavies Elementary/Kentucky	Math	4%	7%	12%	13%
Clay Co. High School/West Virginia	Math		37%	49%	56%
Philippi Middle School/West Virginia	Math		55%	57%	67%
Cocke Co. High School/Tennessee	Math	65%	59%	61%	71%
Vinton Co. High School/Ohio	Math	23%	31%	33%	36%
Beaver Elementary/Ohio	Math	9%	12%	30%	44%
St. Paul High School/Virginia	Math	56%	40%	63%	84%
Bath Co. High School/Kentucky	Science	2%	8%	9%	13%
Logan Elementary/West Virginia	Science		50%	56%	59%
Beaver Elementary/Ohio	Science	11%	16%	32%	46%
Meigs High School/Ohio	Science	27%	31%	35%	42%
St. Paul High School/Virginia	Science	69%		74%	84%

Ohio. Figure 20 compares the percentage of students in ARSI schools passing the mathematics and science sections of the Ohio Proficiency Tests for the years 1997 and 1999. As can be seen, significant improvement was made in mathematics in 8 out of the 12 catalyst schools whereas 8 of 9 schools made significant gains in science. Ohio ARSI elementary schools made significant gains in all but one district (Meigs Eastern) in mathematics. (Figure 21) At the district level, Manchester High School, a Cohort 1 Catalyst School, has posted significant improvement in both science and mathematics when compared to other Adams County schools. (Figure 22)

Figure 20 ARSI Cohort I Schools-Percent Students passing Ohio Proficieucy Tests

School	Grade	Math 97	Math 99	Science 97	Science 99
Beaver ES	4	11.6	43.4	16.3	45.3
	6	22.2	41.9	18.5	30.2
Eastern ES	4	NR	44.6	NR	43.9
	6	NR	62.5	NR	51.8
McConnelsville ES	4	41.9	40.8	28.8	55.3
	6	48.8	66.7	38.1	43.5
Syracuse ES	4	26.9	40	19.2	40
	6	71.4	33.3	33.3	40.7
Vinton Co. HS	9	61.5	63.4	NA	75.8
	12	46.2	35.5	45.6	38.7
Meigs HS	9	63.8	70.6	NA	69.2
	12	18.1	28.6	37	41.3
Manchester HS	9	51.3	37.3	NA	52.6

Figure 21 ARSI Catalyst School Performance

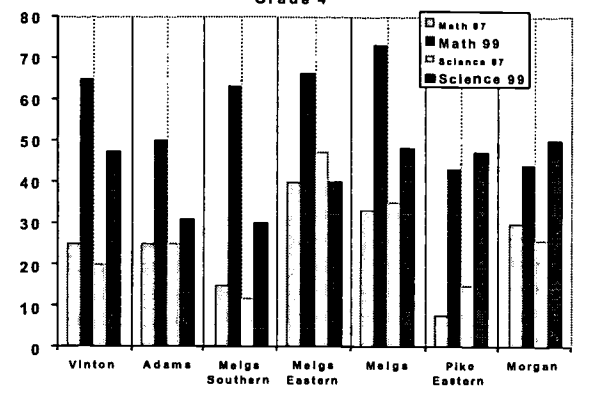


Figure 22. Comparisou of ARSI Catalyst School (Manchester H.S.) with Other Adams County High Schools

	95 - 96		96 - 97		97 - 98		98 - 99		99 - 00	
	M	S	M	S	M	S	M	S	M	S
Manchester HS	40.2%	46.4%	51.3%	59.0%	45.7%	65.4%	37.7%	52.6%	65.1%	73.8%
North Adams HS	58.5%	44.3%	57.0%	46.1%	60.7%	60.7%	56.7%	58.9%	73.6%	72.2%
Peebles HS	46.6%	30.6%	47.3%	51.6%	41.4%	61.2%	56.1%	71.9%	36.4%	60.2%
West Union HS	40.7%	36.8%	46.6%	36.2%	42.6%	55.6%	47.2%	54.4%	64.3%	71.4%

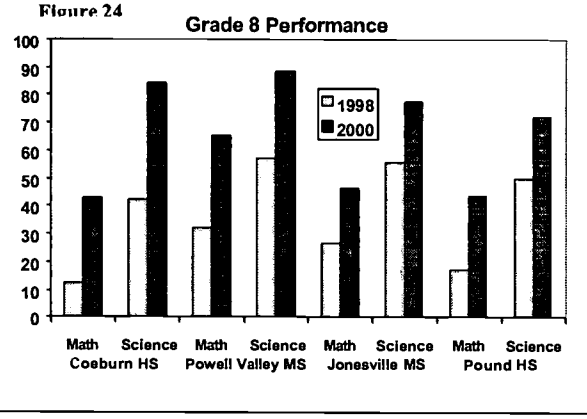
Virginia. Students in Virginia Catalyst Schools were among the Top Improving Schools on the spring 99 SOL assessments. Figure 23 shows the performance of Cohort I Schools—those participating in ARSI activities for three years. All grades tested in all schools show improvement in mathematics from 1998 to 2000 whereas 5 of 7 grades tested in science show improved performance during this two year period.

Figure 24 shows the percentage of students passing the Virginia Standards of Learning (SOL) Tests at grade 8. All ARSI middle schools show gains in both science and mathematics. Districts having strong support for ARSI from their administration and have successful Teacher Partners are showing the greatest gains in the region.

Figure 23 Cohort I Student Performance in Virginia Catalyst Schools

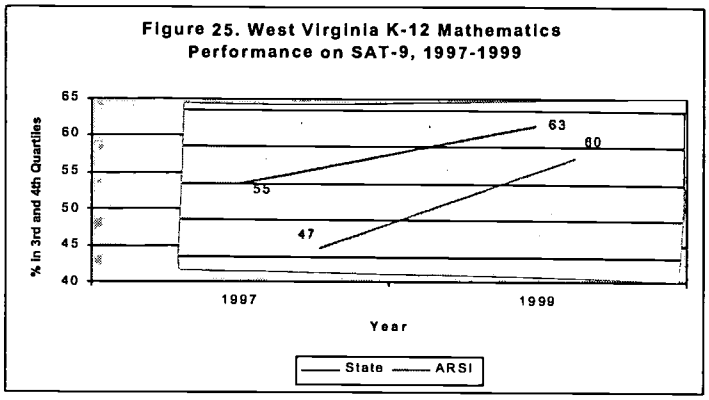
	Grade	Content	1998	2000
Clintwood ES	3	Math	34.21	71.43
Clintwood ES	3	Science	28.95	75
Clintwood ES	5	Math	44.83	75
Clintwood ES	5	Science	44.83	61.11
Clintwood ES	8	Math	51.43	65.57
Clintwood ES	8	Science	82.35	80.33
St. Paul HS	HS	Math	63.01	93.21
St. Paul HS	HS	Science	74	88.83
St. Paul HS	8	Math	4	61.9
St. Paul HS	8	Science	2.04	100
Powell Valley MS	5	Math	51.09	57.55
Powell Valley MS	5	Science	54.41	52.83
Powell Valley MS	8	Math	32.05	65.47
Powell Valley MS	8	Science	57.05	88.24

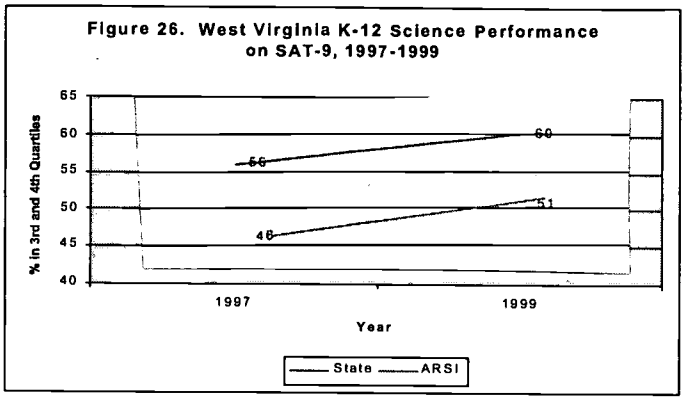
Figure 24



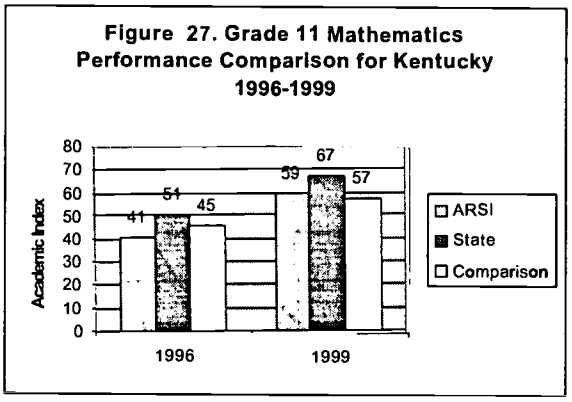
West Virginia. Students in West Virginia are considered "proficient" if they score above the 50th percentile on the SAT-9. To determine progress over time, the student assessment data for West Virginia has been aggregated to compare movement of K-12 students from the lower assessment Quartiles to the 3rd and 4th Quartiles. Figures 25 and 26 compares the percentage of students scoring in the 3rd and 4th Quartiles in 1997 and 1999 in mathematics and science. These data show a significant

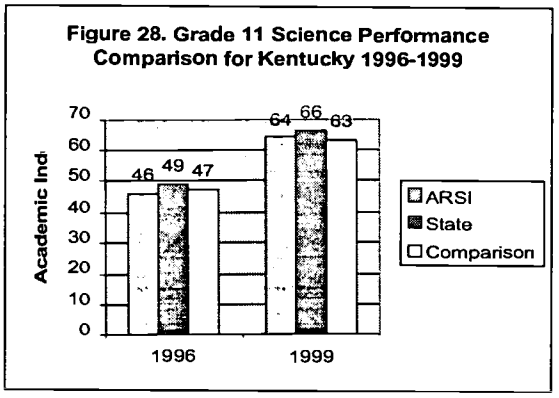
improvement in the percentage of students scoring at the upper two Quartiles and also indicates the ARSI schools are "closing the gap" between themselves and the state average.



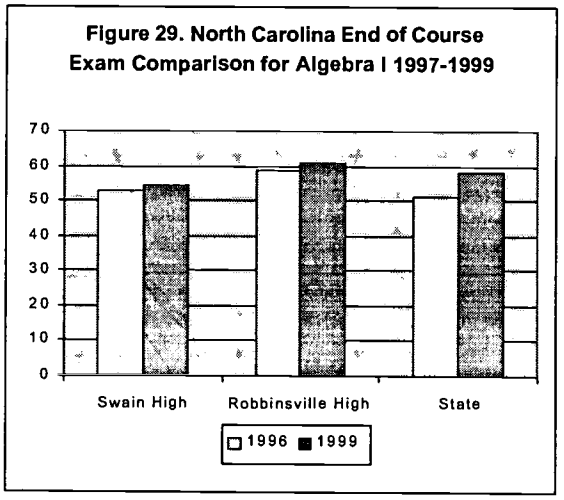


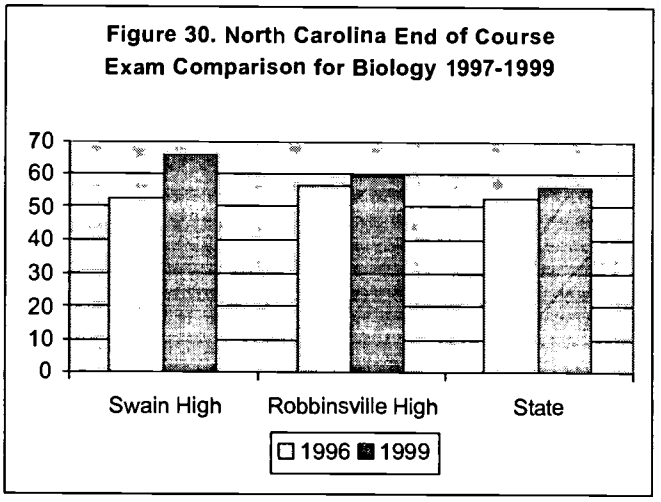
Kentucky Eleventh grade students in ARSI districts in Kentucky scored below both the state and regional averages in both science and mathematics at the outset of the ARSI project. Figures 27 and 28 demonstrate the changes in student performance recorded for the period 1996 through 1999. In both mathematics and science, ARSI student achievement scores have improved more than the regional comparison districts and the gap between ARSI district scores and the state average has been significantly reduced.





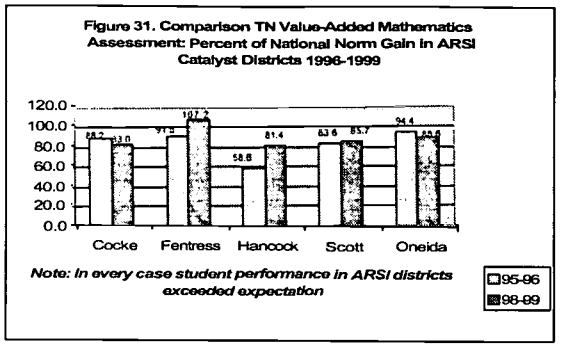
North Carolina Only two districts in North Carolina are eligible for the ARSI project, Swain and Graham Counties. In both counties, the ARSI Catalyst School is the county High School. Figure 29 and 30 shows the improved performance on end-of-course exams for Algebra I and Biology. Students in both high schools posted improved scores from 1996-1999 and Robbinsville High exceeded the state average on the Algebra I exam while both Robbinsville and Swain High Schools exceeded the state average on the Biology exam in 1999.

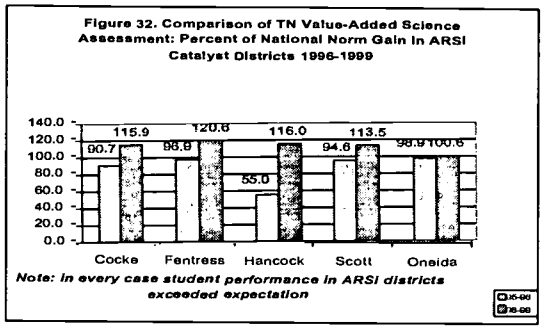




Tennessee The state of Tennessee utilizes "value added gains" as one measure of school achievement. "The minimum value or expectation is that students will gain a year's average growth (compared to the national norm) for a year's instruction in each subject area. This is expressed as a 100% gain. Higher or lower performance is rated accordingly." (From: Tennessee Department of Education, "How to Interpret the Report Card) Figures 31 and 32 show the comparison of mathematics and science assessments for 1996 to 1999 in ARSI districts. As can be seen, student performance in mathematics exceeded the expectation in four of five districts and student performance in science exceeded the expectation in all five districts.

Student achievement for a single ARSI district is shown in Appendix A.





F. Driver 6: Student Equity Issues

Kentucky ARSI district mathematics achievement scores for 1999 were disaggregated to determine if differences in performance existed based on gender. The disaggregated sample, which represented students at all grades tested, included 1291 females and 1217 males. As can be seen in Figure 33, fewer females score at the novice level (lowest quartile) on the Commonwealth Accountability Testing System student assessment in mathematics at all age levels. A higher percentage of female students also achieved a "proficiency rating" on mathematics at each grade level.

Figure 33. Comparison of Females and Males Scoring at the "Novice" and "Proficient" Levels on the Commonwealth Accountability Testing System Mathematics Assessment, 1999 (Kentucky)

	Elementary School (5th Grade)		Middle School (8th Grade)		High School (11th Grade)	
Level of Performance	Novice	Proficient	Novice	Proficient	Novice	Proficient
Females	21.2%	28.6%	25.6%	23.7%	23.1%	26.6%
Males	24.5%	25.7%	29.0%	21.4%	27.7%	22.5%

In comparing these findings with ARSI core data for all six states, it is interesting to the note the following correlations (Figure 34):

- Females make up a higher percentage of students than males in lower level math courses represented (courses not higher than Algebra 1 and Geometry).
- Females make up a higher percentage of students than males in higher level mathematics courses (Algebra II and up).
- A significantly higher percentage of females than males scored a "C" or higher in all mathematics courses taken although a slightly higher percentage of males scored a "C" or higher in calculus (a course normally taken after the 11th grade assessment).

Figure 34. Male and Female Mathematics Course Enrollment and Achievement in ARSI Schools based on Core Data for 23 School Districts in Six States

Enrollment/Achievement Data	Females	Males
Number/Percentage of Students Enrolled in Lower Level Math Courses	3602 (52.5%)	3161 (47.5%)
Number/Percentage of Students Enrolled in Higher Level Math Courses	1189 (54.6%)	987 (45.4%)
Number/Percentage of Students Achieving a "C" or Higher on Lower Level Math Course	2139 (57.2%)	1598 (42.8%)
Number/Percentage of Students Achieving a "C" or Higher on Higher Math Course	1912 (54.1%)	1625 (45.9%)
Number/Percentage of Students Achieving a "C" or Higher in Calculus	84 (48.3%)	90 (51.7%)

These data indicate that there is a need for ARSI schools to examine the curriculum, instructional methodologies, resources, course-taking patterns and other learning opportunities as well as cultural and community expectations to determine why there is an observed difference in performance based on gender.

Kentucky ARSI district science achievement scores for 1999 were also disaggregated to determine if differences in performance existed based on gender. The disaggregated sample, which represented students at all grades tested, included 594 females and 670 males. As can be seen in Figure 35, the distribution of males and females was similar for each category

on the Commonwealth Accountability Testing System student assessment in science at both the elementary and middle school levels. At the high school level, however, a significantly higher percentage of female students scored at the novice level whereas a corresponding higher percentage of males achieved a "proficiency" rating.

Figure 35. Comparison of Females and Males Scoring at the "Novice" and "Proficient" Levels on the Commonwealth Accountability Testing System Science Assessment, 1999 (Kentucky)

	Elementary School (4th Grade)		Middle School (7th Grade)		High School (11th Grade)	
Level of Performance	Novice	Proficient	Novice	Proficient	Novice	Proficient
Females	39.6%	9.3%	99.2%	0.8%	20.7%	19.8%
Males	41.7%	9.3%	99.2%	0.8%	27.9%	31.6%

In comparing these findings with ARSI core data for all six states, it is interesting to the note the following correlations (Figure 36).

- Enrollment in lower level science courses is slightly higher among females.
- Enrollment in higher level science courses is slightly higher among males and significantly more males were enrolled in Physics.
- A significantly higher percentage of females earned a grade of "C" or higher in lower level science courses, whereas a greater percentage of males earned a "C" or higher in the higher level science course, and a significantly higher percentage of males earned a "C" or higher in physics (more than a 3/2 ratio).

Figure 36. Male and Female Science Course Enrollment and Achievement in ARSI Schools based on Core Data for 23 School Districts in Six States

Enrollment/Achievement Data	Females	Males
Number/Percentage of Students Enrolled in Lower Level Science Courses	2848 (51.2%)	2609 (47.8%)
Number/percentage of Students Enrolled in Higher Level Science Courses	589 (49.6%)	599 (52.4%)
Number/Percentage of Students Achieving a "C" or Higher on Lower Level Science Courses	1898 (55.5%)	1523 (44.5%)
Number/Percentage of Students Achieving a "C" or Higher on Higher Level Science Courses	439 (47.8%)	479 (52.2%)
Number/Percentage of Students Taking Physics	209 (43.5%)	271 (56.5%)
Number/Percentage of Students Achieving a "C" or Higher in Physics	137 (39.6%)	209 (60.4%)

Science enrollment and achievement patterns for males and females in the six ARSI states are consistent with the Kentucky assessment data indicating higher student performance by males at the secondary level. These data indicate that there is a need for ARSI schools to examine the learning opportunities afforded girls in higher level science courses. The overall curriculum, instructional methodologies, resources, and course-taking patterns as well as cultural and community expectations need to be examined to determine why there is an apparent gender difference in both enrollment and performance in higher level science courses.

SUMMARY

The ARSI model has proven to be a successful reform strategy for the Appalachian region. As a result of ARSI's efforts:

- A corps of science and mathematics leaders has been established.
- Student achievement has increased in science and/or mathematics in the Appalachian region served by the ARSI project.
- The quantity *and* quality of science and mathematics learning opportunities for students have increased.
- Regional collaboration and support for science and mathematics reform efforts has improved.

The primary goal of establishing "a sustainable system to support standards-based science and mathematics instruction" is nearing fruition and should be realized during Phase II of the ARSI project.

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