The Challenge of Separating Project Effects on Student Achievement: The Case of ARSI and AMSP

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Appalachia

- Geographical isolation
- Slow economic growth
- Household income is 62% of the national average in Appalachian Kentucky, 81% in Appalachian Tennessee, and 71% in Appalachian Virginia (Appalachian Regional Commission, 1997)
- More than one-third of children in the Central Appalachian region have been living in households with income significantly lower than the poverty line (Applied Population Laboratory, 2000)

Impact on Education

- The teachers in rural schools are, as a group, younger and less experienced than their urban counterparts (Kannapel & De Young, 1999; Williams, 2005)
- Recruiting and retaining teachers has become a big challenge for all administers in rural schools
- Teacher quality has become another concern when there is less professional development opportunities for rural teachers compared to their counterpart in urban schools

"The list of local barriers is extensive and includes lack of resources, low tax base, geographical and cultural isolation, low socioeconomic status, low value placed on education, low self-esteem perpetuated by a welfare system, low expectations for students' education achievement due to parents' life experiences and regional values, dysfunctional families, lack of awareness of role of education in students' future, lack of role models and professionals in the community to provide community leadership, lack of awareness of how to obtain supplemental funding through grants in many cases, inadequate facilities to attract more talented teachers, insufficient staff development and distance to training sites, and in-service professional development often lacking in quality and content." (Royster, 1994, p.70)

Educational Reforms

- Major capacity-building efforts in education started in 1995 with the Appalachian Rural Systemic Initiative (ARSI), a ten-year project sponsored by the National Science Foundation (NSF)
- The goal of ARSI was to work with school districts to accelerate improved performance in mathematics and science for all students through high-quality, standards-based teaching supported by aligned and coherent local and regional educational efforts

ARSI

- "catalyst school" --- the model of reform in mathematics and science for the rest of the district.
- A "Community Engagement Team" --- to reinforce school and community leaders of the importance to improve programs in mathematics, science, and technology
- As technology played an important role in overcoming the regional isolation, ARSI staff focused on helping both teachers and students use technology to improve mathematics, science, and technology skill levels
- Local resource collaboratives located at area universities have been developed to initiate and lead local ARSI's reforms

Impact of ARSI

- From 1996 to 2000, ARSI worked with catalyst schools from 52 school districts in 47 (out of 66) targeted counties, developing a strong network of committed and competent teacher partners who played an important role in education reform and community building in the region
- After completing professional development in ARSI, teachers in the region showed better preparation in content and pedagogical knowledge, more frequent use of standards-based classroom instructions, and more positive attitudes toward mathematics, science, and technology

AMSP

- the Appalachian Mathematics and Science Partnership (AMSP), a five-year project sponsored by the NSF, aimed to improve mathematics and science learning opportunities for students and teachers in a broader range of Appalachian school districts.
- The overall goals of AMSP are to eliminate the achievement gap in mathematics and science for K-12 students in the region and to build an integrated K-12 and higher education system for this underserved region to insure the selection, development, and career-long support of a diverse and high-quality mathematics and science teacher workforce.

AMSP (continued)

- AMSP expects to increase student achievement in mathematics and science and the number of students who enroll in advanced mathematics and science courses in all partner school districts
- AMSP expects to increase the number of pre-service teachers who can demonstrate a good understanding of standards based content and pedagogical knowledge in mathematics and science and the number of in-service teachers who can implement standards based and inquiry oriented programs in mathematics and science education

AMSP (continued)

- AMSP has been working to develop an elementary through graduate school mathematics and science education infrastructure to fulfill the needs of mathematics and science pre-service and in-service teachers in the region.
- AMSP has been working to bring together K-12 school districts, institutions of higher education, and community organizations to overcome difficulties in mathematics and science education in Appalachia.
- AMSP has been devoted to pre-service teacher preparation, in-service teacher quality, administration support, and student access to advanced learning opportunities.

Research Questions

- When multiple educational projects operate in an overlapping manner, it is a challenge to separate unique project effects on schooling outcomes
- Separating Project Effects on Student Achievement --- The Case of ARSI and AMSP
- A successful separation of project effects between ARSI and AMSP is critically important for both projects to evaluate their educational programs and plan strategies
- This research question is particularly challenging given that ARSI and AMSP used many identical schools

Special Case

- We considered Kentucky as an ideal special case
  - Appalachian Kentucky is one of the targeted regions of both ARSI and AMSP
  - headquarters of both projects at Lexington, Kentucky
  - AMSP has 38 partner school districts in Kentucky, 8 in Tennessee, and 5 in Virginia
  - The research condition is mature in Kentucky with its state wide Commonwealth Accountability Testing System (CATS) generating sufficient annual testing data on students and schools

Data

- The student testing data for Kentucky has been selected to compare the program effect of ARSI and AMSP in terms of the performance of K-12 mathematics and science students
- Data came from the Kentucky Department of Education that runs state-wide testing programs to monitor academic performance of Kentuckian students

CATS (Commonwealth Accountability Testing System)

- CATS includes the Kentucky Core Content Test (KCCT) (a nationally norm-referenced test) and the well-known Comprehensive Test of Basic Skills (CTBS)
- Schools can compare their scores to the absolute standard of 100 on a 140-point scale to determine how well their students performed
- Throughout the scoring and reporting process, the scores for students are kept together so that teachers and administrators could use them to evaluate how effectively the school taught the students

Data Mining

- Students started to take CATS tests in the spring of 1999
- We obtained two databases with three years of testing data in each
- One database contains achievement data from 1999 to 2001, and the other from 2002 to 2004
- These databases accidentally represented a nature break between ARSI and AMSP. We decided to analyze these databases individually

- students' KCCT mathematics test results in Grade 5, 8, and 11 from 1999 to 2001 and again from 2002 to 2004
- students' KCCT science test results in Grade 4, 7, and 11 from both 1999 to 2001 and again from 2002 to 2004
- students' CTBS mathematics test results in Grade 3, 6 and 9 from both 1999 to 2001 and again from 2002 to 2004

Data Mining (continued)

- The second decision we made in analyzing these data was to remove city schools from our analysis because both ARSI and AMSP targeted rural Appalachian regions
- We excluded schools located in Louisville and Lexington, the two urban cities in Kentucky with a population over 250,000 in each city

Research Methodology

- Different from previous approach, which only examine aggregated students test scores at the school level and treat school as uniform unit of analysis, multilevel analysis has been utilized in this study
- Multilevel analysis effectively accommodates the hierarchy in education data and simultaneously examine student and school differences in relation to treatment effects of a project (Raudenbush & Bryk, 2002)

Analysis

- Data hierarchy with students nested within schools
- A three-level HLM model was developed with students (i) nested within testing occasions (years) (t) nested with schools (j)
- Relative effects of ARSI and AMSP on schools' progress in mathematics and science achievement during 1999 – 2001 and 2002 – 2004.

$$Y_{itj} = \alpha_{0tj} + \sum_{p} \alpha_{ptj} X_{pitj} + \varepsilon_{itj}$$

- In this first-level model, student achievement in mathematics or science is represented as school average achievement, adjustments of characteristics of students within each school and an error term unique to each student

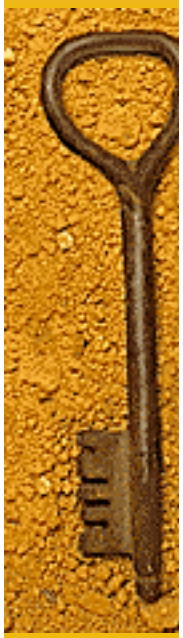
$$\alpha_{0tj} = \beta_{00j} + \beta_{01j} Year_{tj} + \mu_{0tj}$$

- This second-level model is a growth model that models schools' average achievement scores with the time variable
- For each school, either mathematics achievement or science achievement will be examined at one specific grade level longitudinally from 1999 to 2001 and again from 2002 to 2004 in hoping to find different program effects happening in these two time periods

$$\beta_{01j} = \gamma_{101} + \gamma_{011} ARSI_j + \gamma_{012} AMSP_j + \nu_{01j}$$

- This third-level model examines the contribution of ARSI and AMSP on school rate of growth
- β_{01j} represents rate of growth during either from year 1999 to year 2001 or from year 2001 to year 2004 in the field of mathematics or science

- Overall, 18 models have been developed in order to compare the program effects of ARSI and AMSP and examine the interacting effects of both programs on schools' performance and progress in mathematics and science in rural schools in Kentucky in terms of students testing results



	1999 – 2001		2002 – 2004	
	Effect	SE	Effect	SE
KCCT Grade 4 Science				
Initial status	541.85	(0.39)	550.78	(0.41)
Rate of growth	3.88	(0.22)	5.03	(0.20)
KCCT Grade 5 Mathematics				
Initial status	551.43	(0.50)	563.35	(0.54)
Rate of growth	4.09	(0.25)	7.34	(0.26)
KCCT Grade 7 Science				
Initial status	492.66	(0.65)	498.48	(0.70)
Rate of growth	1.32	(0.23)	3.39	(0.24)
KCCT Grade 8 Mathematics				
Initial status	518.51	(0.83)	523.92	(0.87)
Rate of growth	3.87	(0.27)	4.48	(0.27)
KCCT Grade 11 Science				
Initial status	529.25	(1.05)	532.58	(0.99)
Rate of growth	2.21	(0.36)	2.53	(0.32)
KCCT Grade 11 Mathematics				
Initial status	514.56	(1.16)	519.26	(1.22)
Rate of growth	3.00	(0.38)	4.21	(0.36)

CTBS Grade 3 Mathematics				
Initial status	611.64	(0.43)	620.72	(0.46)
Rate of growth	3.42	(0.25)	3.39	(0.28)
CTBS Grade 6 Mathematics				
Initial status	657.66	(0.58)	661.73	(0.68)
Rate of growth	1.55	(0.27)	2.18	(0.32)
CTBS Grade 9 Mathematics				
Initial status	685.10	(0.89)	685.76	(0.97)
Rate of growth	1.33	(0.38)	3.17	(0.32)

Effects of ARIS and AMSP on Change in Mathematics and Science Achievement in (Rural) Kentucky, 1999 – 2001 and 2002 – 2004

	ARIS		AMSP		ARSI + AMSP	
	1999 – 2001	2002 – 2004	1999 – 2001	2002 – 2004	1999 – 2001	2002 – 2004
KCCT Grade 4 Science	-0.03	2.74	1.78	-1.30	1.08	1.39
KCCT Grade 5 Mathematics	-1.62	2.40	-0.43	-2.01	4.32	-0.77
KCCT Grade 7 Science	1.83	3.11*	-0.23	5.11*	0.50	0.32
KCCT Grade 8 Mathematics	1.61	5.85*	0.41	4.97*	-0.52	-1.52
KCCT Grade 11 Science	0.18	-5.18	0.94	-3.22	0.28	5.84*
KCCT Grade 11 Mathematics	-0.32	-13.92*	0.29	-0.36	4.63*	6.99*
CTBS Grade 3 Mathematics	-1.32	1.34	1.42	6.50	0.45	-2.49
CTBS Grade 6 Mathematics	2.06	1.21	-1.30	-4.04	6.30*	-3.12*
CTBS Grade 9 Mathematics	-4.17	10.15*	-0.35	1.96	0.95	1.13

Note. * $p < 0.05$. Although ARIS is completed in 2002, ARIS schools are examined for change in mathematics and science achievement during the period of 2002 – 2004 (post-program effects). Although AMSP is started in 2002, AMSP schools are examined for change in mathematics and science achievement during the period of 1999 – 2001 (pre-program effects).

- The present evaluation represents a first attempt to separate and compare project effects using an advanced statistical model and longitudinal data across multiple grade levels
- One research advancement that further studies may consider is to obtain detailed in-service profession development programs offered by ARSI and AMSP for each grade level to explain why one project is more successful in a certain subject at a certain grade level than the other
- The results of our analysis may serve as good baseline data for future project assessments and provide useful information for large-scale project developers