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Missouri-Iowa Science Cooperative (Science Co-op): Rural Schools-Urban Universities Collaborative Project

Shymansky, James A

Introduction

Pressure on schools to address waning student interest and poor achievement in science, technology, engineering, and mathematics (STEM) has continued unabated since the publication of A Nation at Risk (1983), Science for All Americans and Benchmarks for Science Literacy (American Association for the Advancement of Science [AAAS], 1989, 1993), and the National Science Education Standards (NSES, National Research Council [NRC], 1996). The TIMSS report (International Association for the Evaluation of Educational Achievement, 2000) and the Program for International Student Assessment (PISA, Organization for Economic Co-operation and Development [OECD], 2006) results substantiated concerns that US students are falling behind students in other industrialized countries. These mounting concerns ultimately led in part to the passage of the No Child Left Behind Act of 2001 (NCLB, 2002), which now requires the annual assessment of students' performance in language arts, mathematics, and science.

The current call for reform in science education led to significant funding from the National Science Foundation (NSF) for "systemic change" projects at the state, urban, and local levels. These initiatives were focused primarily on (1) high-quality professional development (PD) of teachers' content and pedagogical content knowledge and (2) the availability and utilization of high-quality instructional resources, assuming that these would lead to (3) improved inquiry-based teaching practices translating into (4) improved student performance. Many projects focused on urban and suburban systems. However, the Science Co-op Project focused on under-represented, underserved, rural, isolated school districts and elementary and middle school science programs. This project assumed that success would be based as much on good engineering in designing solutions that addressed the available resources and local constraints as much as on good science. The project title reflects a basic metaphor for the design and problem solution-farm cooperatives-a historical approach used in rural America to face the economic and political demands placed on small farmers. This brief report provides insights into the design and results of the four factors in the modelPD, resources, classroom practices, and student achievement (see Shymansky, Annetta, Everett, & Yore, 2008, for a more detailed report).

Context

Systemic change requires serious consideration of the system and subsystems involved. In the case of the Science Co-op Project, this meant two state education agencies (Iowa Department of Education and Missouri Department of Elementary and secondary Education), 36 school districts (25 in Iowa and 11 in Missouri), about 1,500 teachers, and approximately 20,000 students spread over 40,000 square miles. The enormity and complexity of the project are partially reflected in these numbers and further complicated by the fact that Iowa does not have an official statewide science curriculum and assessment program while Missouri has both. Historically, Iowa ranks amongst the leaders in the USA for literacy and science achievement while Missouri ranks below average in both.

The target school districts were small and geographically isolated, and many faced significant economic pressures leading to unexpected high attrition among school administrators and teachers. Furthermore, this project focused on consolidated school districts that are ferociously independent. These differences not only encouraged diversity and autonomy at the school district, school, and classroom levels but also contributed to the challenges of effecting systemic reform. Science Co-op attempted to address these concerns with a design mat incorporated a cascading leadership model that gradually moved leadership from a project-centered team to a local leadership team of advocates, coaches, and administrators in each school district across the five years of the project. Local PD activities were supplemented by regional facilitators in face-to-face meetings and regional electronic workshops and presentations via interactive television (ITV). The instructional changes involved moving toward a constructivist-oriented, learning cycles teaching approach, utilizing NSF-funded curriculum materials (FOSS, STC, Insights, combinations of modular and textbook programs, local units, etc.) and the development of local auricular supplements, resource people, and assessment strategies.

The consistent features across all subsystems in the Science Co-op Project were the NSES, children's misconceptions, and elements of constructivist-oriented inquiry teaching (learning cycle). AU teachers were required to develop teaching resource binders (TRBs) for all science units in their grade-level teaching assignment that adapted the resources to local conditions and their students. The TRBs

contained connections between the unit's objectives, state benchmarks or NSES content, inquiry, and social context standards and adaptations of available curriculum resources and programs.

Data Collection and Analysis

Formative and summative evaluations were applied to the professional development experiences, resources, teacher perceptions, classroom observations, and student performance. Some evaluation data were collected annually, while others were collected biannually. Experienced test constructors developed the questionnaires, tests and protocols used in the project and observers were certified by common training and calibration workshops on an annual basis (Horizon Research Inc. [HRI]; see horizonresearch.com/LSC/ for instruments and complete description of projects). The quality, validity, and reliability of these data varied within reasonable limits (see Shymansky et al., 2008, for a complete report). Since instruction and learning effectiveness identified in small rural districts could be associated with a specific teacher, all analyses (descriptive statistics, analysis of variance, t-tests) were restricted to the project-level and were based on random samples of PD activities, questionnaires, tests, telephone interviews, and classroom visits.

Results

Random samples of PD activities (5 to 8 per year) were observed across the project's term using HRI scales for the individual categories; capsule ratings indicated that these activities were judged to be high quality, rated as accomplished effective PD to exemplar PD. Random samples of 10 teachers interviewed each year confirmed these claims. By project's end, 583 (46%) of the 1,269 targets, "steady-state" teacher population received more than 129 hours of professional development (compared to 13% for all LSCs). There was a teacher turnover rate of 25%, a principal turnover rate of 56%, and a superintendent turnover rate of 67% over the five years. All districts and schools achieved the project's objective of 14 inquiry-based units in K-6 with very few not having 2 in each grade level. Surveys of 300 teachers randomly selected by HRI at the start (2000) and then in the final year (2005) of the project suggest that teachers on the whole were teaching more lessons per week (3.3 vs. 3.0) but on fewer topics annually (4.9 vs. 3.9) for more minutes per week (120 vs. 114) during the school year. These results are consistent with the less coverage of topics/more depth of consideration theme promoted in the NSES (1996).

The quality of classroom practice was tracked by observing random samples of 16 teachers identified by HRI on a biannual basis. These data indicated improvement in all categories (5-point scale: not reflective to extremely reflective of best practices) and capsule rating (8-point scale: ineffective instruction/passive learning to exemplary instruction) of the HRI Classroom Observation Protocol (Table 1). ANOVA and pair-wise i-tests of the means for the three years revealed significant main effects and differences between the successive ratings with the greatest differences occurring between the 2000 (baseline) and 2005 (post-project) ratings.

Students' science performance was judged by their perceptions of science instruction and their content test scores. Grade 3 and Grade 6 student responses to 5-point scale (strongly disagree to strongly agree) items on two forms of the Student Perceptions Of Classroom Climate (SPOCC). Student responses were positive or slightly more positive at the end of the project than at the start of the project. The use of my ideas, the family interest, and attitude toward science subscales, areas of major focus in the interactive-constructivist learning cycle and the adaptation strategy used in the project, were significantly higher for Grade 6 girls-a point at which girls (and even many boys) often lose interest in science.

The cut-off scores on the Missouri Assessment Program (MAP-Science) and the Iowa Test of Basic Skills (ITBS-Science) were used to evaluate student science achievement of students in Missouri and Iowa Science Co-op schools respectively. The externally set cut-off scores represent the percentage of students classified as having achieved a proficient or advanced level of understanding of the tested standards. The MAP and ITBS data indicate that the percentage of Grade 3 and Grade 7 students achieving proficient or advanced performance levels in 2005 exceeded the 2000 cohort by 21% and 10%, respectively, in Missouri and by 9% and 3%, respectively, in Iowa.

Closing Remarks

The Science Co-op's successes are not only in the results reported here, but are also found in its impact on (a) science instruction and learning for future students in these rural school districts and (b) the procedural solutions to providing PD to isolated teachers and accessing resources to implement the NSES teaching and program opportunity standards for all children. The legacy of passionate, well educated advocates and ongoing leadership for science education (105 teachers achieved masters degrees in science education during the project) is highly valued and much needed in rural America. The value of the hybrid delivery system for PD consisting of IT applications,

communityuniversity partnerships, and cascading leadership have been implemented using existing technologies and proven models and its practical applications have been established. The coop solutions to resources in financially challenged districts-where teachers set up sharing and delivery systems for neighboring districts and rental systems involving a state retired teachers association and area education agencies-were examples of rural ingenuity. Furthermore, the same collaborative spirit was found in how regional clusters of districts networked and shared teachers and local resource people from rural industries and government agencies to enhance many PD activities. We celebrate these schools' and teachers' successes and believe they can be replicated in other rural systems and subsystems.

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James A. Shymansky

University of Missouri

Larry D. Yore

University of Victoria, Canada

Leonard A. Annetta

North Carolina State University

Susan A. Everett

University of Michigan-Dearborn

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