A Case Study of the Science Cooperatives Project: Effecting Local Systemic Change in Rural Missouri and Iowa (NSF Grant ESI 911857)

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Background

The "Science Cooperatives" project (Science Co-op) is a unique "local systemic change" project in that it targets 38 small town and rural school districts in two states, Missouri and Iowa. The project utilizes geographic clusters of districts organized into cooperatives as well as and distance communication technologies to provide the professional development and support activities for the approximately 1200 K-6 teachers involved. Faculty and staff from the University of Missouri-St. Louis, Iowa State University and the University of Iowa working with scientists and consultants and a district leadership team consisting of a K-6 "science advocate," a Grade 7-12 "science partner" and an administrator "local facilitator" form the project planning and implementation team. The average K-6 enrollment in the districts is 421, the mean annual expenditure per student is $5,676 and 39% of the students overall are on free and reduced lunch programs. The 38 districts cover an area of approximately 40,000 square miles.

Instructional Materials

This case involves the FOSS Human Body kit which consist of four sequential investigations focusing on the form and function of the human body. The unit goals emphasize process skills (observations, description skills, etc.) and the development of content understanding in the life sciences. The content goals included understanding of characteristics of organisms: organisms have different structures that serve different functions in growth and survival; and human organisms have systems for movement, control, coordination, and circulation.

Expected Challenges

The primary challenge in almost every instance in trying to develop competent and confident K-6 teachers of science is content--getting them to the point where they understand the big ideas of the topic and feel they can do an effective job in helping students understand those ideas at an appropriate level. A second and almost as daunting a challenge is to convince those K-6 teachers who teach in self-contained classrooms that spending time on inquiry science can pay big dividends for their instructional efforts beyond the science content that the students might learn--in areas like reading, language arts and mathematics. A third challenge, is to develop a level of comfort with hands-on activities--getting teachers to the point where they feel confident that they can make the activities "work" as intended in the kit and less stressed when the activities "don't work" as they thought they would or should. In Science Co-op, we attack all three of these challenges with equal emphasis and enthusiasm.

In addition to the main challenges mentioned above, there are a few other professional development challenges specific to the human body topic worth mentioning. One deals with the problem of content difficulty or appropriateness. The topic is potentially rife with technical vocabulary, which many teachers have stressed in past work with students. Trying to shift the focus from medical terminology to the relationship between form and function was thus seen as a special challenge for this topic. Another minor challenge with this and many other life science topics is trying to get overcome the "yuuhhck" factor--the squeamishness that some teachers feel in working with animal organs and body parts and functions.

The Professional Development

Our Science Co-op project provides professional development via the traditional summer workshop setting and via the more innovative interactive television and Internet technologies during the school year. One-week summer workshops are set up each year in each of the seven project cooperatives. The primary professional development providers for these workshops are science educators from local universities, science education consultants, and science content specialists who attend the professional development for a portion of the week.

During the summer institute, teachers focus on one topic/instructional kit for the entire workshop week where they develop mechanical use knowledge of the kit activities; learn content background on the big ideas related to the topic/kit; identify and/or generate activities that connect the kit activities to reading, language arts and mathematics; and begin to generate a "teacher resource book" (TRB) that lays out a plan for "adapting" the kit into their district's instructional program. We chose the theme of adapting rather than adopting science kits because of our success with it in another LSC project (Science PALs) and because of our collective experience that tells us that the typical K-6 teacher tends to reject anything that takes time from reading, language arts and mathematics instruction. In addition, teachers are required to follow state and local objectives in their science instruction. The kit objectives may not address all of the state/local objectives so the modules are supplemented with additional activities. In the specific case of the "human body" topic, science advocates help teachers locate related grade-appropriate non-fiction and fiction books and mathematics activities and science partners help them locate and use related websites and develop assessment strategies.

During the school year, teachers participate in a series of interactive television seminars presented by volunteer scientists, special topic consultants, and project staff on topics addressed in the previous summer workshops. The seminars are delivered directly to each school district via fiber optic or Internet technology, allowing teachers to participate in real-time discussions with the presenters. A curriculum coordinator, elementary school principal or district superintendent facilitates on-site discussions during planned intervals within the seminars. Teachers are required to participate in 8 two-hour sessions during the school year.

Teachers also attend a minimum of 3 school-year district team meetings where specific units and district science programs and plans are discussed. These meetings are organized and led by the same seminar facilitator with the additional input of a field support person who is part of the main project staff. At the end of the school year, teachers are invited to attend a regional "reflection workshop" where they can share their successes and frustrations related to a given unit with teachers from other districts in their co-op. The total time spent by an individual teacher on professional development activities for one topic during a complete project cycle (summer workshop and school year) is a minimum of 62 hours (40 hour summer institute, a minimum of 16 hours for television seminars, and a minimum of 6 hours for district team meetings). In addition, teachers receive support from a school level science partner, a trained classroom teacher. These "informal" hours of support have been more difficult to track. Each teacher is expected to participate in at least two complete cycles across the five-year term of the project.

Study Sample

Given the large number of districts participating in the project, a "sample of convenience" was selected. Three fourth grade teachers were observed from two districts that were about 20 miles apart. Two of the teachers were relatively new to the project, having just participated in their first summer institute, and the third teacher joined the project at the outset and serves as a "science advocate." All teachers were observed teaching a lesson either from the FOSS "human body" unit or a lesson included in their "teacher resource book" (TRB) for the unit. Each lesson lasted 45 minutes.

Following the observation these teachers were interviewed about their lessons, the unit, and their involvement in the project. One principal and two curriculum coordinators who are serving as local facilitators were also interviewed, and one TRB for the topic was examined for this case study.

The Observations:

The first teacher observed was one of the relatively new teachers to the project. The class was clearly well into the unit on the Human Body as evidenced by the student work in the room. The lesson was primarily a demonstration and discussion about the role of kidneys in filtering waste products and of a filtering system more generally. The teacher had built a model of a filtration system using sand and water flowing through tubes. The teacher demonstrated how the model worked for the students and used a diagram of the kidney system to discuss the functioning of the kidneys. In general, the teacher appeared to understand the content in the lesson and asked questions which engaged students with that content. I had some initial concerns that the model could possibly create misconceptions about how a kidney functions. These concerns were not warranted, however, as the teacher did a nice job of pointing out the differences between the model and how a kidney actually functions.

The second lesson, also taught by a new teacher to the project, focused on the structure and function of the heart and lungs. This teacher also appeared to have a good understanding of the content in the lesson being taught. The lesson started with an "inquisition-like" questioning period about the parts of the heart and lungs. The questions demanded only that students recall facts that they previously learned. Following this questioning, the students gathered around the teacher who did a dissection of a pig heart and lung that she had obtained from a local butcher. While the questioning improved during this portion of the lesson, and the teacher made attempts to make real-world connections, it was clear that she has a long way to go in her recognition of how students think and the implications of this understanding for her instruction.

The final observed lesson, taught by the teacher with the most experience in the project, was a review of the skeletal and muscle systems which took place through a large group discussion directed by the teacher who used diagrams throughout the discussion. The teacher was clearly experienced with teaching this unit, and, unlike the previous two teachers, appeared highly aware of student thinking throughout the lesson.

Impact and Implications

A number of things observed in the classroom visits and gleaned from the interviews with the teachers connect directly to the professional development activities implemented thus far:

*Increased confidence. All three teachers mentioned almost immediately how much more confident they are in teaching science and specifically, how much more comfortable they are in using hands-on activities. One said it this way: "I am now more knowledgeable and organized when I teach science." They all attributed this to the time spent on trying out and trouble-shooting the kit activities in the summer workshops.

*Less is more. None of the three teachers used this expression specifically, but all three indicated that they are now stretching individual units over a much longer time span than they had done previously. One teacher said, "I am not doing any more of those cutesy-short activities." Another said, "The kits are fitting in nicely; at first, I didn't think they would."

*Making connections. All three teachers talked about how their districts are now stressing non-fiction reading skills and how science is a perfect place to incorporate non-fiction print and electronic materials. They also discussed how they are having students write in science--not just journals, but illustrated brochures and short books, even poetry.

*Using student ideas. The most obvious difference between the lessons observed was the emphasis on the monitoring of student thinking during the lesson by the teacher that serves as a science advocate for the project. While I observed all three teachers asking students for their ideas in their lessons and all three shared in the interviews how they are now using KWL charts in science, the more experienced teacher demonstrated much more advanced skill in this area. This would be expected given that the purpose of the 1st summer institute is to develop the teachers' mechanical use of the kits. Student

learning and student misconceptions are discussed in this institute but are not heavily emphasized. Professional development in the 2nd, 3rd, and 4th cycles will deal with these topics in more depth.

*Student questioning. The lessons observed varied in the quality of the questions asked of the students. Again, the first year of professional development does not strongly emphasize this aspect of teacher development but future professional development will as the teacher becomes familiar with the activities in the kits.

Other Work Needed

*System culture. What we need to work on now is creating a "system culture" among the teachers--getting them to shift from an "I'm developing this TRB for my own use" to more of an "I'm developing this TRB because it fits into the district's science program." We have not promoted this perspective too strongly in the first two project years; most teachers have thought of their TRBs as their own property. However, the project staff is sensitive to the fact that a truly systemic program does not allow teachers to claim "pet units" with no regard to their grade level assignment or how it fits into the district's curriculum framework. We have already planted the seeds of building a district set of TRBs with advocates, partners and district administrators and the idea has resonated with them. Evidence of our success will come about when teachers decide to participate in one of the last years of the project to develop a TRB that they themselves are not actually teaching at that time.

*Kit maintenance/distribution. Most of the districts have not yet addressed the question of kit maintenance beyond having individual teachers note what is missing after completing a unit. In those districts where there is more than one section of students at a grade level, most have implemented a plan for sharing and/or rotating kits. The Science Co-op staff purposely avoided focusing on kit maintenance/distribution problems in the first two years to keep attention on teacher preparedness issues. We do plan to address the kit maintenance/distribution area more directly in project Years 3-5.