RUNNING HEAD: Using Study Groups in Professional

Using Study Groups in Professional Development to Promote Sustainable Curriculum Reform in Science

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Abstract

Researchers and theorists have long focused on teachers as the keys to making student-centered reform in science a reality in the classroom. However, sustaining and growing science reform beyond a few units developed in a workshop to a more complete shift that teachers pursue and districts support is not as easily achieved. Alliance for Science was developed to provide staff development that is easily transferable to the context of classroom activities but also to help teachers implement reform from "where they are." A multifaceted series of staff development training workshops was provided. This evaluation outlines the key components of a successful inquiry-based science professional development model. In this study, success was defined using teachers as the unit of analysis with the creation and implementation of reformed science curricula the major benchmarks measured. The discussion provides an important analysis of the role of study groups for other educators while addressing sustainability issues in other professional development venues.

Using Study Groups in Professional Development to Promote Sustainable Curriculum Reform in Science

Literature Review

Researchers are continuing work in understanding how to create inquiry based science curriculum that promotes student learning for all types of students and abilities. Both science content and process knowledge gains have been found when science is based on inquiry rather than textbook learning (Krajcik, Marx, Blumenfeld, Soloway, and Fishman, 2000). At the same time, strong "teacher effects" mediate the gains students make (Krajcik et al., 2000). This reality is clear: there are considerable teacher-level and system-level variances affecting the implementation of reformed science curricula. For teachers, there are individual differences in their preparedness to implement and sustain student-centered inquiry science in their curricula as well as the prerequisite science content knowledge required for facilitating meaningful learning. In addition, the importance of context becomes clear in the differences that exist across local school districts in the focus on science content and science process and the support for developing new curriculum.

Researchers and theorists have long focused on teachers as the keys to making student-centered reform in science a reality in the classroom. "Many of the problems with constructivist…science probably can be solved through improved curricula, quality control of problem sets, and better professional development" (Clune, 1998, p. 147). Changes in teacher preparation for standards-based inquiry science must include an on-going process to address new and ever-changing standards as well as science content and pedagogy (Schmoker & Marzano, 1999; Kumar, 1999). It is important that these changes in teacher preparation be grounded in constructivist, inquiry-based principles as well (Wenk, 1999). This transformation of teachers' pedagogies, classrooms, and curricula has been well documented using a variety of constructivist professional development models (Bainer & Wright, 1998; Shymansky, Yore, & Anderson, 1999; Hammrich, 1999; Borman, Kromrey, Katzenmeyer, & Dell Piana, 2000; Di Biase, 2000; Fuller, 2001). However, sustaining and growing science reform beyond a few units developed in a workshop to a more complete shift that teachers pursue and districts support is not as easily achieved.

Conceptual Framework

Effectively preparing teachers to lead the reform requires a multi-faceted, flexible approach that is sensitive to the varying classrooms and the teachers who will be implementing the curriculum.

Alliance for Science was developed to "provide staff development that is easily transferable to the context of classroom activities" (Reichel, 1999, pg. 2) but also to help teachers implement reform from "where they are." Some teachers, schools, and districts are well-prepared to create and implement a full standards-based inquiry curriculum. In fact, their existing pedagogy may already promote constructivist learning environments. But this scenario is not the most common. Some educators still have not adopted constructivist ideals as part of their "personal" theory of learning or as a consistent part of their practice. In addition, teachers have needs related to building basic science content knowledge. Past experience building effective professional development series to promote science reform made several realities evident. Foremost, many educators do not have access to the necessary resources to plan and implement inquiry-based rather than text-based science. Also, a surprising number of schools have not invested time and personnel to building a science curriculum that is focused, consistent across classrooms within the school or district, and aligned across grade levels.

A multifaceted series of staff development training workshops was provided during which groups of teachers developed curriculum maps intended to include all three science content areas (life, physical, and earth science) built on an inquiry-based instructional framework. The workshops addressed various important themes, including:1) Creating curriculum maps to align lessons to state standards; 2) Developing inquiry-based science units; 3) General staff development on issues such as constructivism and inquiry-based science concepts. The curriculum maps were generated as a result of staff development workshops held throughout Lake County during the 1999-2000 school year. These workshops were consistent with designs for staff development intended for science educators (Darling-Hammond, 1999; Loucks-Horsley, 1998).

Participating teachers attended these sessions to "connect standards and curriculum with the context and processes teachers need to develop in order to effectively work as facilitators of learning." (Reichel, 1999). This served as a way for these teachers to engage in a form of "sense-making" (Puttick & Rosebery, 1998) in their ongoing understanding of science content and teaching. A key to this process was the use of the learning cycle model (National Science Foundation, 1997; Rubba, 1992; Flick, 1993) which serves as an instructional framework to assist teachers in addressing science inquiry processes in ways beyond a simple hands-on, discovery approach (Settlage, 2000). The learning cycle served as a template for curriculum development. The cycle included the Focus (invitation), Explore (inquiry), Reflect (inquiry), Apply (summative assessment) aspects of science learning. Included with the Focus was an opportunity for students to address misconceptions about science concepts. These opportunities led to learning experiences which allowed students to seek evidence to re-construct the misconception.

However, sustainability of the reform achieved by these workshops is of considerable concern. To address this issue, Alliance for Science sponsored problem-oriented study groups that connect teachers across the region who were trying to address specific science curriculum issues in their schools. The goal of these study groups was to promote "teacher leaders" who can continue working to expand and improve the inquiry science that has been started by the Alliance for Science project.

This paper will focus on Year Two (of three) of Alliance for Science outcomes, specifically on the effective use of study groups to promote and support teacher leaders in sustaining science reform throughout the county.

Methodology

The Professional Development Model

The concept for the professional development model reported here emerged from almost 10 years experience helping science teachers implement inquiry based science in the classroom. The model addresses theoretical as well as application-level needs of teachers from all grades and levels of available resources. There were several important tenets to ensure effective professional development experiences, including creating on-going development using strategies that modeled those teachers will use with their students as well as promoting links between the teachers and other parts of the educational system to ensure continuous improvement (Loucks-Horsley, 1998; Darling-Hammond, 1999; see Appendix for Final Report).

Because of the widely ranging needs of the participating districts, schools, and teachers, professional development was adapted to meet the needs of the individual participants. Workshops and training was adapted to and included some combination of unit or staff development or providing resources in addition to participation in study groups.

The most widely attended sessions for Year 2 were those centered on curriculum mapping (237 participants, $\overline{X}$ hours = 4.9 per participant), unit development (387 participants, $\overline{X}$ hours = 7.34 per participant, and staff development (278 participants, $\overline{X}$ hours = 3.6 per participant). In addition to individualized workshops, a 2 credit science content course was provided to 35 participants (first come, first serve basis).

Study groups fit into the model by more intensively supporting individual teachers who then served as leaders in reforming the curriculum in their schools and districts. The study groups promoted fuller participation in the reform of science as well as generated valuable professional and practical connections with the resources needed to sustain the changes being implemented. It was not only their exposure to this approach to learning, but also the "carefully orchestrated professional development that allows time for participants to gain experience and time to synthesize their experiences" (Reichel, 1999, page 2). The study groups provided the participating teachers the opportunity to work in groups of six based upon their interests (e.g., a particular science standard, learning style, or science misconception). Following the group study and trial attempts, they implemented what they had learned in their own classrooms. They also continued to meet monthly to discuss and debrief.

Participants

In Year 2, the Alliance for Science project served 729 teachers from 65 schools in 23 districts.

For the study group, enrollment was limited to 33 teachers total (a beginning group and an advanced group) and had a waiting list of teachers wanting to get in the sessions. The groups were comprised of elementary and high school teachers interested in creating new science units for their students in the monthly, 3 hour sessions held in the 2000-2001 spring semester. For some, the resulting units will be readily adopted by all teachers in their grade level at their school. For others, they will be the only classroom in their school adopting the inquiry-based unit.

All of the teachers are familiar with the facilitator and have worked with the Alliance for Science project to varying degrees.

Data Sources

Three data sources for the study groups were utilized in year two. First, the beginning study group was observed once and the advanced study group was observed twice. Second, Personal and Group Logs were analyzed. Finally, focus groups were conducted with each study group. This served as a logical follow-up to the participant perspectives from the surveys of year one.

Results

Analysis of personal and group logs showed the range of new practices being implemented as a result of participation in the study group. Several different themes emerged in the analysis of the best practices or strategies the groups were employing. Analysis of the focus group sessions revealed how the study groups and the facilitator operated to support the teachers and the science curriculum changes they were trying to implement.

1. Infusing Inquiry.

All participants implemented new inquiry projects at some level. Some teachers also used demonstration lessons to generate student investigation. The teachers shared several comments that indicate the extent to which they believe these activities were successful.

> "The students really enjoyed the singing bottle, they really understood resonance on a deeper level. The previous day we had seen observations & discussed resonance. It seemed to work fairly well" (DPDE, Study Group Personal Log).

> "Both of these activities [Soundless Bell and Straw Oboe] had the students involved and understanding the basic concepts of each. They allowed for easy discussion of the concepts that included all of the students, not just the kids that enjoy science. The activities also allowed certain students a chance to get more in-depth with their predictions/hypotheses. Not all students were able to do this, though" (MSDE, Study Group Personal Log).

2. Scope of Curriculum Changes.

Some teachers created lessons using the Learning Cycle approach or used demo lessons to generate student interest.

> "I did not re-teach the lesson, but reflected instead on making the lesson better for next year. By using the learning cycle model I think my students will gain a more complete understanding of the sink/float concept and be better prepared to design a boat with limited adult assistance" (PHLC, Study Group Personal Log).

Other groups were focused on integrating their science curriculum across grades or across content areas.

> "Articulation and taking earlier grade units and expanding to the next level will build the continuity. Quantity of lessons can be truncated when piggy backed units created quality through repetition of concepts" (RRTD, Study Group Personal Logs).

Some teachers used backward mapping to connect standards to the curriculum, a process where the teacher connects unit goals and activities with the corresponding state standards for science.

> "Concept of backwards mapping has helped to set goals for activities in classroom" (CME, Study Group Personal Log).

Finally, many teachers focused on writing and using rubrics for assessment

> "Students worked on their gravity cars -- wheels and axles a concern - made changes and tested cars - asking them all kinds of questions about their cars and what works & what doesn't work" (PHFM, Study Group Personal Log).

The study groups provided the participating teachers the opportunity to work in small groups based on common interests, like a particular science standard, the learning cycle, or a science misconception or common pedagogy. Following the group work they implemented what they had developed. They also continued to meet monthly to discuss and debrief.

The study groups seemed to be used by teachers to get the work of "reforming science" done that they could not address during regular hours. Teachers seemed to enjoy the collaborative atmosphere and appreciated the immediate access to resources that the Alliance for Science facilitator provided. Some teachers were unsure if they could implement inquiry-based science without this additional support. Analysis of transcripts from two focus group sessions, one for the beginning group and one for the advanced group, revealed several important themes related to the effectiveness of the study groups for sustainability of reform.

3. Most valued resources from study groups

Teachers expressed several areas of support that were vital for developing and implementing effective standards-based inquiry science, including:

- Easy access to a knowledgeable practitioner-oriented facilitator
- Easy access to current curriculum development materials
- Collaboration with educators across the county

- Time to focus on curriculum development in conjunction with scaffolding by facilitator
- Motivation provided by other educators and by project facilitator

Some of the comments during the focus group poignantly express how appreciative teachers were of the study group process.

> "Anne [Alliance for Science facilitator] was a great resource...every time you were stuck with what direction to go she'll tell you …help you out with it or send you the place to get it or bring it in the next week for us. We would leave her a list…what we needed. And the next week she would have it for us (Teacher 1, Beginning Study Group Focus Group).

> "It's important to have somebody around that is so knowledgeable with all the materials and the methods, knowing the state goals and learning…" (Teacher 4, Beginning Study Group Focus Group).

4. Most salient sustainability concerns

Teachers had a lot of concerns, particularly in the more invested advanced study group, about how to sustain the changes and continue to expand the scope in upcoming years. Their concerns and suggestions included:

- Continued external support (outside of district) is key to sustaining interest and quality of the professional development.
- Continued allotment of financial resources at county level is important because costs are too hefty for a single district.
- The networking and promotion of "teacher leaders" are important for growing and expanding reform.

Teachers were passionate in describing the important aspects of sustaining the new science curriculum in their classrooms and beyond.

> "…just coming to these things opens up your mind on ways to teach science. So if there is the time and money to have these type of study groups, I think, anyone could do it with the advice…resources that Anne [Alliance for Science facilitator] has and money Anne had….and you know get a big group of teachers together and talk about things …"(Teacher 4, Advanced Study Group Focus Group)

> "She really, I thought she built on the idea that she had a core of teachers from all over the county and knew…we would be there and…bring in others. I feel that's important to keep the network in place because we know what we need and then we can bring others along…" (Teacher 1, Advanced Study Group Focus Group).

Discussion and Implications for Practice

Teachers are implementing components of inquiry-based science in many areas of their curriculum, including incorporating technological design or inquiry projects and utilizing cooperative groups. In general, these teachers are shifting the learning environments in their classrooms from students "watching science" to students "doing science." These changes are further supported by mapping the science curriculum to state standards, integrating across grade level and sometimes content area, as well as creating assessments and rubrics more appropriate to inquiry-based science.

Teachers valued the experiences they had in the study groups. The time, expertise, and resources were all important components to their success, elements well-documented in the literature (Bainer & Wright, 1998; Shymansky, Yore, & Anderson, 1999; Hammrich, 1999; Borman, Kromrey, Katzenmeyer, & Dell Piana, 2000; Di Biase, 2000; Fuller, 2001). Continued financial support and collaboration with educators across the county emerged as important sustainability issues.

This evaluation outlines the key components of a successful inquiry-based science professional development model. In this study, success was defined using teachers as the unit of analysis with the creation and implementation of reformed science curricula the major benchmarks measured. The discussion provided an important analysis of the role of study groups for other educators addressing sustainability issues in other professional development venues. However, there are several questions that need to be addressed to determine the real level of reform occurring in classrooms. How consistent are the curriculum changes across all districts? Have all the districts reached a "minimum level" of infusing inquiry into the science curriculum? What local and state policies affect sustainability? Finally, and most importantly, student learning outcomes must be measured to determine the most significant outcome of any professional development: real knowledge changes for students. Because evidence of change in students' science content knowledge following change in the teacher or the system has been mixed (Singer, Marx, Krajcik, & Chambers, 2000; Shymansky, Yore, & Anderson, 2000), several salient issues need to be examined at the student level. Researchers should be mindful that scientific literacy in students is inherently linked to the linguistic, cultural, and academic diversity of the students in the classrooms (Yerrick, 1998; Lynch, 2001). So we continue to ask the questions of how to reform science, while always remembering the reason why we're reforming science: scientific literacy for all students.

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