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Engaging Stakeholders in Productive Meetings to Reform Science Education

A course is described which prepared graduate students to engage stakeholders in productive meetings to reform science education and to prepare for future leadership roles in science teacher education reform.

Have you ever spent hours in a meeting in which you thought progress had been made only to come back to a follow-up meeting and find yourself addressing the same issues as if they had never been discussed before? Leaders all over the United States have been experiencing this ever since funding agencies and other political institutions began requiring active participation from multiple stakeholders in science education decision-making to forward the reform of our enterprise.

This paper presents suggestions for leaders in science education to assist in developing effective stakeholder groups contributing to the reform in science education. In this political climate initiatives to reform science teacher education and science education for students K-16 are expected to involve stakeholders from a variety of sectors in schools, universities, and the community. Facilitating the organization and work of such groups usually falls to the current leaders in science education in schools, state agencies, and universities. The diverse backgrounds of the various stakeholders are a double-edged sword. On one hand, they provide new ideas from which to develop creative programs. On the other hand, the varied perspectives that enrich the base of ideas also create enormous communication barriers that often impede progress. "Understanding the multitude of perspectives held by the varied stakeholders in science education is essential to ensure that all of us work toward common goals" (Spector, Strong & King, 1996). Leaders, therefore, need to be prepared with an armamentarium of techniques to orchestrate the work of stakeholders.

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The suggestions offered herein emerged from a grounded theory study (Erickson, 1998; Glaser & Strauss, 1967; Jacobs, 1987) of an exercise in facilitated stakeholder discussion aimed at creating an ideal science teacher education program consistent with today's national goals. The findings are applicable to developing science programs for school students as well. This exercise was conducted in a university doctoral course. Deriving recommendations for ways to facilitate human interactions in groups from studying students in university settings is common practice in the social sciences. The participants in the course constituted a microcosm of stakeholder groups at work throughout the nation in both informal and formal settings. Stakeholders included (a) a formal audience of educators—community college, university science educators, and scientists—science supervisors, teaching practitioners, research scientists, and education specialists, and (b) a community audience representing business, industry, youth development, and education and outreach (e.g. science enrichment programs, teacher workshops, and informal programs).

From this exercise two types of information were learned that are important for leaders when facilitating stakeholder interactions. First, several alternative processes of facilitation were initiated in this course setting in reaction to different forms of resistance. We report the types of techniques that were effective in addressing instances of resistance and fostering open and effective participation by all members of the stakeholder community. Second, we offer several suggestions about how the lessons learned from this facilitation might be applied to professional development workshops and simulations that bring stakeholders together to develop reforms in science education. In the wake of 9/11 professional simulations are becoming a more common tool for professional development in the light of addressing crises. We suggest that similar types of exercises may be meaningful for developing techniques for science education reform.

Helping stakeholders assume the posture of learners is often a challenge.

The National Context

In the early 1990s the National Science Foundation (NSF) indicated there was an urgent need for stakeholder groups to work together collaboratively to design and implement reformed teacher education programs and created the Collaboratives for Excellence in Teacher Preparation (CETP) program to facilitate that reform. The NSF and the U.S. Department of Education began funding Math-Science Partnerships (MSP) and the associated Research Evaluation and Technical Assistance (RETA) in 2001, again requiring large scale, complex collaborations.

The National Institute for Science Education (NISE) (Mundry, Spector, Stiles & Loucks-Horsley, 1999) reported that stakeholders creating a shared vision for teacher education was a critical step toward making science teacher education consistent with national and state goals for reform. The NISE study identified key issues (e.g. culture differences, entrenched roles) that needed to be addressed to reform teacher education and mechanisms (e.g., create shared vision, attend to communication and collaboration) being used by initiatives across the country to address the issues.

Senge (1990) and Novak (1998) stressed that for an organization to succeed, it has to become a learning organization. In such an organization, people work together to generate new knowledge. "… people at all levels are, collectively, continually enhancing their capacity to create things they really want to create." (p. 178). The range of understandings within a stakeholder group suggests that everyone in the group must engage in learning about each other's perspectives and goals and processes involved in reform, and work together in order to create a viable vision. Helping stakeholders assume the posture of learners is often a challenge.

An individual stakeholders' understanding of the meanings engendered in the major documents guiding the reform of science education influences what each stakeholder perceives should be the changes in education to make it consistent with national and state goals for reform. This diversity of perspectives and goals must be reconciled by creating one common vision to which everyone in the group will commit and work. Communication and collaboration are keys to creating that vision.

Two elements of the process for collaboratively creating a vision are establishing (a) an environment of trust and (b) a shared vocabulary (Spector,

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Strong and King, 1996). Since stakeholder groups are composed of people with varied past experiences individuals can be expected to attach different meanings to the same words. A shared language is needed to facilitate "understanding of each other's worlds, strengths, capacities, constraints, and operating norms" (Mundry, Spector, Stiles & Loucks-Horsley, 1999). Significant time must be set aside in order to clarify and negotiate language issues and confront paradigm clashes when they surface (Spector & Brunkhorst, 1999; Simpson. 1997). It is common for stakeholders to under estimate the amount of time, energy, and complexity of the process to create a vision (Simpson, 1997). The need for research on ways to facilitate the process was documented by NISE (Mundry, Spector, Stiles, & Loucks-Horsley, 1999). The study herein responded to the need for additional research on the process of creating a common vision.

The importance of developing learning organizations, or learning communities, among stakeholders has been given great emphasis by the National Science Foundation (NSF) and the U.S. Department of Education in the recent development of the Math-Science Partnerships

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(MSP) and the associated Research Evaluation and Technical Assistance (RETA) grants. Great emphasis has been given to developing incentives designed to fostering reciprocal communication patterns between partner organizations. Similarly, the federal officers responsible for administering development of MSP's have emphasized that organizational change and learning are expected from all members of the learning community, not just the K-12 schools, if an effective learning community is to be developed. The importance of creating a shared vision is even greater as the sizes of the sponsored MSP learning communities are ambitious both in terms of the number and variety of participating organizations.

The Setting for Facilitation

We studied alternative approaches to facilitating the development of a shared vision through a doctoral class composed of individuals representing many perspectives found in typical stakeholder groups. The learning opportunity was structured to provide students with experience functioning as stakeholders faced with the same challenges as other stakeholders in teacher education reform initiatives around the country.

Doctoral students in this class perceived the course to be uniquely structured. It focused on solving a critical problem currently facing the science education enterprise: "How do we design a vision for a science teacher education program that would be consistent with current national goals?" The professor charged students with the responsibility to create options to solve the problem and made a variety of resources available. She intentionally chose not to take the stance of the authority. Instead, her role was as a member of a community of learners who were on an equal playing field. This style of leadership did not conform to students' expectations and there was significant resistance initially to the non-traditional role of the professor. This was reminiscent of resistance in stakeholders, who were brought together in funded projects, expecting the leader to have all the right answers to problems implementing a project.

Stakeholders here were participating in a formal learning opportunity (course) in which in-depth learning about reform was an explicit goal. This may be in contrast to other stakeholder groups who commonly do not start with learning as an explicit goal. The focus of the study was to (a) identify factors that influenced participation and interactions within a stakeholder group of doctoral students, and (b) identify techniques used to facilitate the process of creating a common vision. The intent of the course was to prepare doctoral students as change agents for leadership roles, aligning science teacher education with national and state goals.

Factors Affecting Stakeholder Interactions

Researchers identified ten factors from the analysis that influenced the way participants interacted, communicated and collaborated in the course. Some factors reflected the diverse prior experiences of individuals. Other factors emerged during the process of negotiating and creating a common vision as a stakeholder group. The following is a list of the emergent factors that affected willingness and the way in which individuals participated.

Prior knowledge and status gained from professional experience

1. teaching experience and setting in which it was gained
2. outside influences such as work loads, other commitments, and time constraints
3. prior knowledge and precepts regarding reform in science teacher education
4. beliefs about leadership—(there was some evidence of a natural hierarchy emerging in the group, however, this was discouraged in favor of community building and establishing a level playing field).
5. level of resistance to the belief that reform was a realistic goal

Social status effect from being graduate students in a program

6. standing in the doctoral program—for example, students who were further along in their studies started by being more confident in their assertions about science education (and life in general, if truth be told).

Personal comfort in a group setting

7. level of familiarity among individuals prior to entering this class
8. prior experience in a generative (student-driven) classroom
9. self efficacy regarding the value of his/her contribution to the group
10. level of resistance to open communication

Findings indicated that the difficulty of the task lay in people being willing to make enough of a shift in thinking/learning to construct meaning outside of their "prior experiences" box and collaborate as a learning organization. There was significant resistance initially from many students to the nontraditional role of the professor. Specific factors contributing to resistance were the individuals' expectations of roles and how class should operate. These included prior experience in a generative classroom, self-efficacy regarding the value of his/her contribution to the group, and stage in the doctoral program.

Experience in their jobs also significantly influenced students' participation in the task. They explicitly used prior knowledge from their respective positions (their jobs) as a) the starting point, and b) the constant reference point to solve the problem. The different points of view inherent in their positions revealed differences in beliefs about goals, paradigms, and use of language. Members of this class encountered the same barriers with which stakeholder groups in science teacher reform initiatives around the country were struggling. The barriers encountered required the need to build communication and collaboration skills in order to accomplish the task as a group. Students became aware that they could not succeed at the task by learning independently as they had traditionally done in classes, but instead needed to become a learning organization (Novak, 1998).

"How do we design a vision for a science education program that would be consistent with current national goals?"

Interpretation of the links among the above factors affecting participation revealed five major issues that needed to be addressed to continue the task. These were the need to: 1) reconcile multiple perspectives and multiple goals, 2) build trust among the group members, 3) negotiate language and common vocabulary, 4) resolve paradigm clashes, and 5) develop effective communication skills. Recognizing these issues, in turn, led to the development and implementation of several facilitation techniques necessary to support the vision process for this group of stakeholder learners.

Specific facilitation strategies developed and implemented during the course

In general, the professor's stance as a co-learner in the community, instead of the authority, contributed to various techniques emerging and being tested in response to preceding needs/issues that arose as the course progressed. Designing and implementing these techniques enabled students to develop a sense of ownership in solving the problem of developing a vision and thus ownership of the course. The techniques also created a need for students to intentionally engage in active learning in order to benefit from, and incorporate, information from the resource material available. Ultimately, the strategies facilitated the group becoming a learning organization, willing and capable of designing a common vision for a teacher education program. Table 1 provides a summary of facilitation techniques utilized during this class.

Participants perceived their learning to be very practical as a result of the alternative course structure facilitated by these techniques. The structure provided a mechanism to apply the insights of reform documents to a real world problem with which they would have to deal as leaders, whether in university science education positions, school leadership positions, or from non-academic positions. Students as stakeholders during this course became empowered learners and communicators.

Selective Filtering of Information

Focusing the class on a real world problem at the outset affected the way many students read and interpreted the resources available to them. They perceived that they read the information available to them differently than they would have if they were just critiquing the documents to generate class discussions about reform in science teacher education. One student commented: "Looking at a document just to see what's in the document, or what position a particular author takes on the subject, is different than looking at the document as the data source to solve a problem."

Participants selectively filtered the information that seemed relevant to the problem at hand and went back to the resources on a need to know basis.

Table 1. Facilitation Techniques and Responses

Facilitation techniques developed and implemented during this course.	**Response to the techniques**
Students were asked to generate the agenda for each class session that would facilitate the learning needed to design a science teacher education program consistent with national standards.	Each person examined the available resources, generated questions and posted them on the white board at the beginning of each class. These questions served as the agenda for the session.
A different student served as class facilitator each week.	This contributed to shared responsibility, shared leadership, and a level playing field.
A "round robin" approach to communication was used.	This encouraged all group members to contribute
Questions were used to gather information and clarify meaning in class. This is in contrast to questions being used to test whether someone had learned what he/she was supposed to have studied.	This encouraged intellectual risk taking and building a community of learners.
Synchronous face-to-face conversation during class and asynchronous messages via e-mail postings were used for intra-group communication.	The level of candor in each communication vehicle shifted as the semester progressed and students increased the depth of self-revelation and meaningful conversation. For the first quarter of the semester people seemed to be more willing to share their thoughts using e-mail than they were face-to-face in class. Later in the semester the class interaction became more dynamic and more open, with more risk-taking behavior evident. People were willing to question each other's statements, to agree or disagree with each other's ideas, and to synthesize new ideas into a group consensus.
A computer and projection system were used in class to record dialog. One student typed the salient points during the class discussions.	This helped to further the process of reaching group consensus. The words on the screen seemed to function as an intermediary for conversation. Instead of directly saying to someone, "I disagree with you": students addressed comments to the screen. It appeared that as people focused on the words on the screen, they felt free to say, "No that doesn't mean … it should be said this way". The words recorded during class were then posted on an e-mail. Communication continued asynchronously around the words until group consensus was finalized.
Each student developed a brief presentation about an aspect of reform related to his/her own competence and	Key aspects of these mini-projects were incorporated as part of the vision. Some examples were nature of science, use of time in schools, instructional computing, and patterns of communication. This resulted in each person being recognized as having special expertise that was valued by all. This is a characteristic essential to effective collaboration (Spector, Strong, and King, 1996).

Thus the problem created a perspective for filtering the information in the readings and constructing meanings within the context of the problem. For example, one student commented,

"Everything that we were reading we were reading from the perspective of gathering data that would help to solve a problem."

How do these findings parallel other stakeholder groups?

This study identified four characteristics consistent with collaboration among other stakeholder groups. These were role expectations, leadership, cultural differences, and the amount of time allotted to fulfill a specific goal. Each of these characteristics is described below to illustrate specific examples within this study that parallel key elements identified in previous works (Mundry, S., Spector, B., Stiles, K. & Loucks-Horsley, S., 1999; Spector, B. & Brunkhorst, H., 1999; Simpson, 1998; Novak, 1998; NSF-CETP, 1998; Spector, Strong & King, 1996).

Role expectations.

Students' role: Each stakeholder began the course with entrenched views about prescribed roles in a group context. Initially, students expected traditional roles for the professor and students. However, as the course progressed and the hierarchy flattened these role expectations were modified. An effective strategy to facilitate new role expectations was to assign each group member a different role during each class meeting (e.g. facilitator, recorder). Use of a computer projection system helped to facilitate group consensus and eventually a level playing field of shared contribution and leadership. Some student comments include:

- "I value the exchange as members of the group posit and defend their positions"
- "I am interested in the differences in program ideas between teachers and non-teachers"
- "Tonight, we were really expressing our individual assets and everyone offered a valuable component to the whole"

Professor role: The professor had a high tolerance for ambiguity and great faith in the group process. She had prior experience implementing generative classes and facilitating stakeholders' groups. Her willingness to exercise patience and endure students' frustrations (verbal and nonverbal), because she refused to assume the traditional authority role, was supported by her confidence that the group process would result in a meaningful learning experience for students. She did however acknowledge that her posture as co-learner on a level playing field with this group of students, most of whom she had not known before class, was a high-risk action. In response to exit memos in which students expressed insight and appreciation for something accomplished, she frequently wrote things like:

- "Your enthusiasm and level of participation are an important part of the process."
- "Thanks for staying with it, the ah-ha's will surface as we continue."
- "The process is slow and requires time but you will realize the value."
- "Thanks for the encouragement as this is a high risk strategy I am undertaking."

Leadership

The nature of leadership desired for this course was a shared responsibility rather than one spokesperson for all. However, shared leadership and equal contribution among all members took time to develop. The course began with one student initiating a self-assigned leadership role. However, as the class progressed and strategies were implemented to facilitate shared responsibility, most all group members began to contribute verbally during face-to-face meetings. Shared leadership in light of indirect communication (e.g. e-mail postings) developed sooner in the group than during face-to-face meetings. All members, except two, contributed regularly to the e-mail communications that augmented in-class discussions and served as a means of posting students on-going learning logs (e.g. readings, class process and reflections). Some student comments include:

- "I wish more people would voice opinions, I enjoy hearing what others think"
- "This class has taken on new momentum. It wasn't just that I contributed but I actually had something to say."

Cultural differences

The learning community for this class consisted of participants representing different prior experiences and learning cultures (e.g. teachers to scientist). Only one doctoral student was a full-time student; all others were employed full-time in teaching and/or scientific research. Individuals had different expectations derived from variations in their cultural background (e.g. formal training, other job experience, and life experience). Cultural differences influenced by prior experiences with other doctoral classes and groups were most evident at the start of the course and continued mid-cycle. Following the implementation of the facilitation strategies of round-robin approach, rotating facilitators, and a stream of questions, the strength of this barrier lessened, although never completely dissolved.

- "Personally, I need more direction. Perhaps I will get more guidelines as the class progresses"
- "It is hard to be productive as there is such a broad range of educational backgrounds in this class and teaching experience. This is good in some ways but also has disadvantages"

Element of time

It took a great deal of time to genuinely understand what each individual was trying to express (e.g. the meaning of words derived from different perceptual screens). Clarity seemed to emerge when each individual was given time to expand on his/her conceptual ideas. Use of a round robin approach enhanced this process. Time for clarification also fostered meaningful interpretations of an individual's contributions and added value to the group. Consequently, individuals experienced more self-efficacy as a valued contributor to the group. Although this process was time consuming it resulted in some of the most constructive group dynamics.

- "To be honest, the task ahead seems a bit overwhelming to me. I think we need to buckle our seat belts and hold on for a rough ride"
- " It was great to take the time to expand on each individual's conceptual ideas; although time consuming, I feel time well spent"

Implications for Science Education Reform

The course studied was a learning situation from which to derive suggestions for engaging stakeholders in productive meetings to reform science education. This course can serve as a model to help science education professors a) give doctoral students opportunities to learn to become productive participants in stakeholder groups, and b) provide an experiential base for students upon which they can build the skills they will need to facilitate stakeholders groups. The ultimate goal of this course was to prepare doctoral students for future leadership roles in science teacher education reform. Such roles will likely require them to organize and facilitate stakeholder groups to improve science education at all levels. The mechanisms that emerged to facilitate group problem solving may be helpful to anyone who wants to conduct a formal course or workshop that resembles a working group of stakeholders.

This type of facilitation need not be limited to doctoral education. These techniques can also be applied to professional development workshops and executive development simulation exercises. In these settings the task of facilitation is not limited to developing a single strategic vision. Rather, the goal is to identify the range of strategic visions held by stakeholders that can be effectively meshed into a viable program. A further goal of the facilitation is that stakeholders become more active and reciprocal in their participation as a means of learning the tendencies, strengths and weaknesses of their fellow stakeholders. Since 9/11 this type of simulation has been used to great effect in other areas such as public health, emergency preparedness, and homeland security. The mix of doctoral students involved in this course and the level of their professional experience indicated that these types of facilitations may work to great effect in a non-academic professional development workshop.

Furthermore, these findings have potential to contribute to turning stakeholder groups into learning organizations. Specifically, this research provides additional evidence supporting the need for collaboration and communication among stakeholders and presents techniques for facilitating this valuable process. The present research also supports and is supported by extant literature on trust, communication, group dynamics and collaboration (Mundry, S., Spector, B., Stiles, K. & Loucks-Horsley, S., 1999; Spector, B. & Brunkhorst, H., 1999; Simpson, 1998; Novak, 1998; NSF-CETP, 1998; Spector, Strong & King, 1996).

References

Erickson, F. (1998). Qualitative research methods of science education. In B. Fraser and K. Tobin (Eds.) *International science education handbook*. Kluwer Academic Publishers: Boston.

Glaser & Strauss. (1967). *The discovery of grounded theory.* Aldine Publishing: Chicago.

Jacobs, E. (1987). Qualitative research traditions: A review. *Review of Educational Research*. 57(1), 1-50.

Mundry, S., Spector, B., Stiles, K. & Loucks-Horsley, S. (1999). Research Monograph # 17: Working toward a continuum of professional learning experiences for teachers of science and mathematics. National Institute for Science Education, University of Wisconsin-Madison.

National Science Foundation Directorate for Education and Human Resources, Division of Undergraduate Education (1998). Teacher preparation awards. NSF Collaboratives for Excellence in Teacher Preparation awards. Fiscal year 1998.

Novak, J. D. (1998). *Learning, creating and using knowledge: concept maps as facilitative tools in schools and corporations*. Lawrence Erlbaum Associates: Mahwah, NJ.

Simpson, P. (1988). Transforming teacher education: Minnesota's intervention to produce standards-based science and mathematics teachers. A paper written in response to the question: How do you build a bridge between pre-service education (initial teacher licensure) and inservice education (continuing licensure), all of which is defined here as professional development of teachers? Unpublished paper in NISE Monograph: St. Cloud, Minnesota.

Senge, P.M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday.

Spector, B. & Brunkhorst, H. (1999). Collaboratively studying the efficacy of science and mathematics teacher preparation: A lesson in communication. Paper presented at the annual conference of the Association of Educators of Teachers in Science. Austin, Texas.

Spector, Barbara S., Strong, Paschal N, & King, James R. (1996). Collaboration: what does it mean? In Rhoton. J. & Bowers, P. (Eds.) *Issues in Science Education*. Washington, DC: National Science Education Leadership Association & National Science Teachers Association.

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