Focus Group Background Papers

The attached papers were gathered by the leaders of each Focus Group. Please read them carefully so that you will fully be able to take part in your Focus Group.

Please take this document with you to the meeting of the National Congress on Science Education

Inquiry, Keeping Science In the Schools

Science literacy defined as the knowledge of science and the role of inquiry, is critical to the well being of our nation and a well rounded education for all students at all levels. Teachers of science need to take an active role in promoting the importance of science, especially inquiry, to students, colleagues, community members, and policy makers.

Attached:
"Inquiry, Keeping Science In the Schools" by Randy Johnson

Inquiry, Keeping Science In the Schools

Background:

Today the world is being profoundly influenced by scientific discoveries. People need to make and evaluate decisions that require careful questioning, seeking evidence, and critical thinking.

Not all teachers of science have made the paradigm shift to the current concept of inquiry. In the science education reform movement of the 1960's inquiry was defined in terms of a set of process skills, often with the implication that inquiry could be learned independently of the content of science. *The National Science Standards* (1996) gives a somewhat different definition of inquiry. Inquiry means asking questions and attempting to answer them through investigations involving experimentation and data collection, logical analysis, and searching for information from existing sources. George DeBoer (1997) suggests inquiry is carried out on "researchable questions of genuine interest to students in the context of the content."

Students bring many different experiences, attitudes, and abilities to the classroom. Inquiry-based instruction allows students the opportunity to investigate, reevaluate, and construct new knowledge. According to Rodger Bybee (1997) students bring their current explanations, attitudes, and abilities to the learning environment. Through interactions in the learning environment, inquiry-based experiences, challenging the students' current perceptions provides opportunities to reconstruct their knowledge.

Inquiry requires identification of assumptions, use of critical thinking and consideration of alternative explanations. This requires direct experience and continued practice with the processes of inquiry. Students must **experience** inquiry to gain a strong understanding of its characteristics. Teachers need to introduce students to the fundamentals of inquiry and allow students to practice inquiry.

Many teachers rely heavily on textbook driven instruction along with drill and practice activities even though research shows that an inquiry approach results in higher student achievement. The vast majority of our schools still rely on the traditional "drill and kill" model of teaching science where students study textbooks and answer questions at the end of the chapter. *The National Science Standards* (1996) state that inquiry-based learning is an active learning process where inquiry is "something that students do, not something that is done to them."
A pair of studies from Wisconsin indicates greater achievement when students are involved in inquiry-based programs. A study conducted at the University of Wisconsin (results presented at the March, 2001 NSTA Convention in St. Louis) indicated that after three years of exposure to kit-based inquiry instruction at the elementary level, the number of students scoring in the "proficient" or "advanced" levels on the state's science achievement tests increased from 55% to 80% for the study group.

In the second study, the Einstein Project's Cornerstone Study, students taught with inquiry-based methods were compared to five control schools that were not using inquiry-based methods. 81% of students who studied in inquiry-based classrooms were judged to have mastery of science terminology beyond rote memorization compared to only 20% of students in the control schools.

Michael Kletschy (in press) states that when the inquiry method is used that "science content is covered in greater depth compared to a superficial traditional textbook approach."

There are many common skills that run through all academic disciplines, including inquiry. Critical thinking skills identified as important for various academic disciplines vary, but Wincout (Costa, 1985) lists several skills that are common to nearly all academic disciplines: (1) Enabling skills which include observing, comparing/contrasting, categorizing/classifying ordering, patterning, and prioritizing; (2) Process skills which include skills related to analyzing questions, facts/opinions, relevancy of information, and reliability of information; and (3) Operation skills including logical reasoning, creative thinking, and problem solving skills.

Recent research indicates that the cognitive processes in learning a science are similar to those used in learning a language (Akerson, 2001 and Casteel and Isom, 1994). They also concluded that student proficiency in learning science and language arts might be enhanced by teachers who also understand their reciprocity when taught in an interdisciplinary fashion.

Research shows that school districts where all teachers participate and implement inquiry-based methodology show improvement in achievement test scores in multiple academic disciplines. The El Centro (California) School District implemented a districtwide program that focused on inquiry-based instruction (Klentschy, (in press)). Teachers and principals in the district received extensive training in inquiry-based methodology that was continuous over the four years of the study from 1995-1999. Not only did science achievement scores in the fourth and sixth grades improve the longer students were taught using an inquiry method, but they also showed impressive improvements in their math and reading scores, as well as El Centro's district writing proficiency exam.

The study at El Centro developed out of "a belief that the skills of reading and mathematics are strengthened when taught using the engaging, high interest content" of inquiry based science. With inquiry-based methodology, like the one in the El Centro School District, an effective model is now available that has been shown to improve science learning, promote critical thinking and problem solving, and even improve reading, writing, and math achievement.

Teachers and school administrators are facing enormous pressure to improve test scores of students in their schools in the basic skill areas of math and language arts. Schools are reducing the amount of time and resources devoted to science education, to focus on

improved achievement on math, reading, and writing assessments. This leads to increased fragmentation of science from math and language arts.

Science needs to remain in the forefront in all school reform movements across the country. Furthermore, teachers of science, well trained in inquiry-based science, can take a leadership role in implementing inquiry methodology in all academic disciplines.

Literature Cited:

Akerson, V. "Teaching Science When Your Principal Says 'Teach Language Arts,'" *Science and Children,* April 2001, pp. 42-47

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Casteel, C. and Isom, B. "Reciprocal Processes in Science and Literacy Learning," *Reading Teacher*, vol. 47, 1994.

Costa, A. (editor). Developing Minds: A Resource Book for Teaching Thinking. Association for Curriculum and Supervision, Arlington, VA, 1985.

DeBoer, George, "what We Have Learned and Where Are We Headed: Lessons From the Sputnik Era," http://www.nas.edu/sputnik/deboer1.htm.

Einstein Project, "Cornerstone Study," http://www.einsteinproject.org/cornerstone/indes.html

Inquiry and the National Science Education Standards. National Academy Press, Washington, D. C., 2000.

Klentschy, M., Garrison, L., and Ameral, O. "Valle Imperial Project in Science (VIPS): Four-Year comparison of Student Achievement Data, 1995-1999," *Journal of Research in Science Teaching*, (in press).

The National Science Education Standards. National Academy Press, Washington, D. C., 1996.

Recommendations

- Find ways to get all teachers of science to engage in inquiry-based instruction in their classrooms.
- Identify those common skills that run through all academic disciplines.
- Study exemplary models of inquiry-based methodology and draw on their experiences to develop a program similar to the 6 + 1 Traits of Writing focusing on inquiry.
- Inform all people with a vested interest in educational reform that science and particularly inquiry-based science must maintain the same status as mathematics and

language arts. These programs should not be placed in competition with one another, but can compliment one another to improve student achievement.

Discussion Questions

- Are teachers of science, as a collective group, trained well enough to take a leadership role in educating others on the methodology of inquiry? If not, how can this be improved?
- Is inquiry a thread common to all academic areas? To what extent is it implemented into other academic disciplines in your school?
- What role should teachers of science, chapters and associated groups, and NSTA take to implement principles of scientific inquiry into all academic areas?
- What needs to be done for all teachers, regardless of curricular areas, to practice and teach inquiry skills in their classrooms?
- Should NSTA in conjunction with chapters and associated groups engage in a study of exemplary inquiries based programs and communicate the findings?

Changing the Culture to Meet the Needs and to Overcome Apathy

Science education professional organizations depend upon the ability to engage, activate, enable, and embrace teachers to assume leadership roles. Topics which relate to this issue:

- Exclusive vs. inclusive culture of an organization (the invitation)
- Turn over in the profession (fewer life long career teachers)
- Volunteerism in 2002: demographics and motivating factors
- Organizational changes that are needed to meet the changing needs of today's teachers
- The changing teaching environment-school climate

Attached: "Research on New Teachers Shows a Changing Profession" Press Release from the Harvard Graduate School of Education

The Changing Role of Professional Development

The science education reform movement and legislative mandates are expecting the professional development of teachers to impact student achievement. The role of associations in providing quality professional development must:

- Be aligned through the use of standards with local improvement efforts
- Directly influence teacher classroom practice
- Utilize partnerships
- Be based on the needs of the schools/teachers
- Be sustained over a period of time

Attached:
"The Changing Role of Professional Development" by Joyce Tugel
"Learning science and the Science of Learning" chapter 12
Please also see the report of the Professional Development Task Force on www.nsta.org/congress2002

The Changing Role of Professional Development

Background

Local school improvement efforts are not aligned with the national science standards. According to Powell, Short, and Landes, "The professional development that supports the implementation of standards-based curriculum materials requires a transformation in teachers' ideas about and understanding of subject matter, teaching, and the learning of science" (*Learning Science and the Science of Learning,* p. 122). If teachers are to adopt curriculum, instruction and assessment strategies consistent with the national science standards, they must be provided with opportunities to learn the content, pedagogy, and constructivist approach to learning science through immersion in inquiry.

Professional development is often perceived to be 'one shot' workshops, and is not sustained over a period of time. Stiles and Mundry note that if the purpose of professional development is to foster expert teachers of science, teachers need to develop the following characteristics: make connections and recognize meaningful patterns between new knowledge and guiding concepts; deeply understand new knowledge and connect it to previous knowledge; learn new content within multiple contexts and apply that new knowledge to unfamiliar contexts; practice and implement new learning; develop the ability to reflect on and monitor understanding and recognize when misconceptions occur; and receive feedback from others and engage in collegial interactions (*Learning Science and the Science of Learning*, p.143). Creating such conditions requires a more comprehensive approach to professional development.

Professional development opportunities often do not directly influence teacher classroom practices. There is a growing commitment to professional learning approaches that encourage change in teacher classroom practice as described by Loucks-Horsley et. al. (*Designing Professional Development for Teachers of Science and Mathematics*, pp. 42-61). The approaches include: immersion in inquiry into science; immersion in the world of scientists; curriculum development, adaptation, implementation and/or replacement units; workshops, institutes, courses, and seminars; action research; case discussion; study groups; lesson study; and examining student work and student thinking. These strategies are not to be utilized in isolation; rather, every professional development plan should incorporate a variety of strategies that will meet the established goal.

Professional development services are frequently not based on the needs of a school district. "School districts currently invest in science-related professional development programs assuming that these programs help their teachers and schools meet standards of quality, are standards-based, and are designed for optimal teacher learning and transfer to the classroom. But too often the plans these districts develop and the programs they invest in for their teachers are disjointed and of poor quality" (NSTA PD Task Force Report, December 2001). The professional design process is more than simply 'doing'. The design framework laid out by Loucks-Horsley et. al. *(Designing Professional Development for Teachers of Science and Mathematics*, p. 17) has gained widespread acceptance as a PD design tool for schools. The framework guides and informs the

design work of professional development, and includes articulating the knowledge and beliefs of the team; considering the context of the school setting; identifying critical issues of the district; deciding upon PD strategies; and implementation, including setting goals, plan, do, and reflect.

Quality science education is a community responsibility, and potential partnerships with scientists in business, industry, and universities are often ignored. Loucks-Horsley et. al. describe key elements that create successful partnerships between teachers and scientists, including collaboration between teachers and scientists based on support and cooperation for each partner; roles for scientists as content experts and/or providing access to equipment, research and materials; involvement that is consistent with both partners' values, goals, and objectives; and benefits to teachers and scientists *(Designing Professional Development for Teachers of Science and Mathematics,* p. 134). Expectations must be realistic with regards to the kind of relationship that will be established, and both teachers and scientists will require orientation to their partners' working environment. Although partnerships involve a high level of commitment, the outcome can be a powerful learning experience for teachers and their students.

Recommendations: Quality professional development must

- Be aligned through the use of standards with local improvement efforts
- Be sustained over a period of time
- Directly influence teacher classroom practices
- Be based on the needs of the schools/teachers
- Utilize partnerships

Discussion Questions

- What obstacles hinder sustained professional development opportunities in your state?
- How can we encourage districts to align local school improvement efforts with the national science education standards?
- What role can state associations play in providing quality professional development?
- What action can the National Congress on Science Education take to address the issues surrounding the professional development of teachers?

References

Bybee, R.W. (Ed.) 2002. *Learning Science and the Science of Learning*. Arlington, VA: NSTA Press.

Loucks-Horsley, S., Hewson, P.W., Love, N., and Stiles, K.E. 1998. *Designing Professional Development for Teachers of Science and Mathematics.* Thousand Oaks, CA: Corwin Press.

Mundry, S. (Chair), December 2001. *Report of the Professional Development Task Force.* National Science Teachers Association; Arlington, VA.

Integrating Curriculum

Science is often taught in isolation. Meaningful connections among the sciences and other curricular areas provide a rich educational experience. In order to accomplish this the education community should develop:

- Establish new curricula inter and intra disciplinary collaborations provide professional development of teachers.

The definition of integrating curriculum depends on the level (K-6, 6-12, etc). What is integrating curriculum?

Attached:
"Integrating Curriculum" by Dick Dettmer

Integrating Curriculum

Background

Our lives, the lives of our students, and their lives once they are in the world of work are not set up in the way most schools teach. Many schools have curriculums that are set up to teach one subject at a time. Real life situations demand that we draw upon information from our knowledge of Science, Social Studies, Language Arts, and Math at the same time. Should schools plan a curriculum that presents these types of situations to students? How should this be done?

The following statement comes form the University of California at Berkeley's National Center for Research in Vocational Education

Though integration as a curriculum design technique builds and reinforces both general education and vocational education, educators must remain cognizant of the most critical element to any curriculum design: the learner. Learners' needs, and the relevancy of the curriculum designed to meet those needs, represent the "bottom line" to the curriculum integration process.

What does this learner relevancy mean to the curriculum designer?
Combining general and specific content;
Focusing on learner values, culture, discovery, thinking processes, and workplace experiences;
Creating learning situations that transfer learning and knowledge;
Reflecting the complexities of knowledge and its application in diverse contexts, problems, and situations.

What does this learner relevancy mean to the curriculum designer?
What does the student need to know and be able to do?

Several professional groups have issued position statements which indicate they support interdisciplinary learning at the Pre-K-grade 4 level. Does NSTA want to become involved with a similar statement?

In NSTA's Position Statement on Elementary School Science there is a statement that "mathematics and communication skills are an integral part of science instruction." Is this statement addressing the issue of Integrating Curriculum?

Fogarty, R., and Stoehr, J. (1991). Integrating Curricula with Multiple Intelligences: Teams, Themes, and Threads.
Palatine, IL: Skylight Publishing, Inc.

Achievement Gap/Accountability

There is a wide disparity in student achievement. This is attributed to a lack of equity in the following areas:

- Teacher quality
- Tracking
- Class size
- Funding
- Learning environment

What do teachers need to overcome this challenge?

Background information for this Focus Group is not yet available. Please visit www.nsta.org/congress2002 for updates.

Partnerships

Science knowledge is ever changing and increasing. The responsibility for improving the equality of science education rests with:

- Government (funding) resources- e.g. NSF, Eisenhower
- Corporate resources
- Family/public resources
- Higher education support
- Career mentoring

In order to provide a real world perspective and application for science, collaborations are essential. We do it better in partnerships.

Attached:
"Partnerships with Businesses and the Community" by Steven Ethen

Partnerships with Businesses and the Community

Who is interested in improving education? Everyone! Politicians are always talking about education because they know it is something that concerns the vast majority of citizens. Local businesses and larger corporations ... hospitals and museums ... and don't forget parents ... these are some of the groups interested in what is occurring in education. Education is important to them for many reasons. Science is ever changing and increasing. The responsibility for improving the learning and equity of science education rests with the family, communities, businesses and corporations, higher education, and the government. Collaborations, through partnerships, are essential to provide a real world perspective and application for science.

Getting "out there" doesn't and shouldn't mean abandoning your students. Making students your prime partners means putting them and their learning at the core of all other partnerships you build. Involve students in their own learning, in the partnerships you build with people outside school, and in how you manage educational change. Making students your first partners is the prime directive in building all other partnerships "out there" beyond the school (ENC, 1999).

What should be the relationship between schools and the community, or corporations and businesses, or parents? Partnerships need to meet the needs of all the parties; this needs to be a win-win collaboration.

Aim for long-term relationships with the major stakeholders where they are involved in the decision making process. Partnerships are more likely to be successful and long lasting when the various groups feel they are accomplishing common goals. The priorities of the schools need to be in agreement with the priorities of the partners. How do you answer what is in the partnership for the business?

Partnerships work best where there are clearly defined goals that interest the various groups, and there is agreement on what needs to be invested: money, resources, staff time, etc. It is very helpful when all groups can contribute something. What are some examples where schools can help businesses?

Look for opportunities to develop partnerships. Survey students/parents. Some interesting partnerships have started in this manner. Build on small successes and publicize your efforts. Some districts have volunteer coordinators (paid or volunteer) who develop connections between the community and the school. What are some other methods of developing partnerships?

The following questions need to be considered when discussing partnerships:
How might schools, parents, communities, and businesses plan together to be sure students are well prepared for whatever they choose to do after they graduate from high school or college?
How do we know what the standards are for good performance in business and in school curricula? How do these standards compare, and are they compatible?

What current examples of curriculum programs or packages help connect the needs of the workplace to the things that students are doing and learning in schools?
Is there some way to provide professional development for educators to help them understand business procedures, policies, and change? What educational factors need to be bridged between school and businesses?
What existing literature can help e3ducators understand and evaluate the connections between school and business? What are some exemplary informational resources?
What are some of the promising math/science related careers for students to consider as they think of their future? What school-based learning should they persue to prepare for these careers?
What kind of learning and instruction will help prepare students to be well-informed citizens capable of rational decision-making?

Thorson, Annette. (January 2001). The Real Bottom Line. ENC Focus 8 (1) p. 4-5.
You, Aleta. (January 2001). Guidelines for Effective Partnerships. ENC Focus 8 (1) p. 18 - 19.
Damian, Carol & Herrera, Terese. (January 2001). School Partnering: A Plus for Students and the Community. ENC Focus 8 (1) p. 48.
Kelly, Janet, Stetson, Renae, & Powel-Mikel, Angiline. (April 2002). Science Adventures at the Local Museum. Science and Children 39 (7) p. 46 - 48.
Case, Steven B. & Miller, William E. (November 1999). Partners in Research. The Science Teacher. 66 (8) p. 42 - 45.
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