The National Congress on Science Education
2003 Focus Group Background Papers

Enclosed are a series of background papers that were created by the NCSE Planning Committee. Please read these papers prior to the meeting and **bring your copy with you to the meeting.**

Index:

Science for All! All for Science!
Diversity Equity for Students of Science

Background

A commitment to providing quality science education for all students requires an understanding of the special needs and culture of each child, regardless of disability, gender, race, language, sexual orientation, class, ethnicity, or religion. Moreover, it requires an unyielding belief that science benefits by embracing and welcoming all students, as they bring unique viewpoints and approaches to our ever-expanding field. While this commitment offers great advantages for the student, his or her peers, and our profession, it often poses challenges for teachers of science who may not have the training necessary to provide appropriate, inquiry-based science for diverse learning styles, world views, or special needs. This paper uses disability as a paradigm for diversity equity, and provides an overview of some of the issues and pedagogical approaches surrounding the teaching of science to students with special needs. It is meant as a starting point for discussion on disability in particular, and diversity in general, with an understanding that each area within the broad category of diversity may require a unique and tailored approach.

(This section is based on the article: Kahn, Sami. (2003). Including All Students in Hands-On Learning. *ENC Focus 10*(2). 14-17. Used with permission of Eisenhower National Clearinghouse. Visit the ENC Online: www.enc.org

According to the National Center for Education Statistics (2002b), 13.2 percent of all students have disabilities and are receiving special services under the Individuals with Disabilities Education Act (IDEA). This law guarantees all youth with disabilities a free, appropriate education in the least restrictive environment. Special education services provided by school districts are mandated under IDEA.

That 13.2 percent translates to 6,195,113 students, a 30 percent increase in the last decade. Moreover, 47 percent of students with disabilities spend 80 percent or more of their day in regular education classrooms (National Center for Education Statistics, 2002a).

The steady increase in students identified and served under the IDEA, as well as the growth of inclusion, is highly beneficial to students. But it creates special challenges for general education teachers, many of whom were not trained in special education.

Including students with special needs in science and mathematics classes can be particularly daunting. In secondary schools, science and math are often taught by teachers who are not fully certified or who may have even less knowledge of special education than do most elementary teachers (Gewertz, 2002).

It is essential that all students have the opportunity to participate in inquiry-based lessons in mathematics and science. Such lessons are highly relevant to students' lives, provide visual and tactile cues, offer opportunities for peer communication, and encourage skills that are necessary for future learning and employment. And of course, they are often fun!

But how can hands-on lessons be modified to accommodate all students with disabilities? Udvari-Solner (1996) suggested that one of the first considerations should be whether an accommodation is necessary at all; that is, whether the student can actively participate in the lesson without any adaptations and achieves the same outcome.

Asking this initial question will help teachers avoid a common danger encountered by students with disabilities: the cumulative effects of low expectations. Sometimes low expectations are characterized by having the student with disabilities be only an observer during science experiments or math activities. Other times, well-meaning teachers provide peer assistance in activities that require writing or fine motor coordination when assistance is not necessary (Stefanich, 2001). In other words, it is essential not to assume that a student needs modifications. Do not make alterations until you are sure that they will increase the student's participation level and comprehension.

Once you have decided that adaptations are indeed necessary, what kinds are available? Scruggs and Mastropieri (1992) recommended the following modifications for the inclusive classroom depending on the special needs of the students.

Vocabulary: Evaluate which vocabulary words are essential to understanding the concepts. As much as possible, simplify language and teach vocabulary in advance of the lesson. Use mnemonics and picture clues to help students remember concepts. Provide peer assistance and tutoring when appropriate.

Instructional Delivery: Modify your rate of delivery and shorten lessons. It is important to use a variety of instructional strategies while providing structure. Teach prerequisite information in advance, and include visual organizers and concrete examples. Provide additional application activities performed in cooperative learning groups. Integrate other content areas into math and science.

Text: Provide graphic organizers and framed outlines that highlight important vocabulary and key concepts. Partner students for reading assignments and tape-record readings of text selections. Supplement textbooks with children's trade books at various reading levels.

Materials: Provide multitextured materials and concrete models. Manipulatives should be easy to use and large enough for uncoordinated hands. Choose materials that can be taken apart and reassembled. Use manipulatives for linear measurement. When mixing, use materials that can be felt or heard when the solutions are stirred or shaken.

Assessment: Provide authentic, performance-based assessment that can be easily linked to math and science processes. Allow for multiple opportunities to demonstrate acquired knowledge and skills. Implement portfolio assessment. Make time to teach test-taking skills and study techniques. Although many resources for teachers exist, it is often challenging for teachers to link their specific challenges with solutions unless there is adequate support within the school system, and with assistance from parents. Training, collaborative planning time with special education teachers and therapists, and more curriculum geared toward meeting the needs of special students must be made available.

Discussion Questions

- Are teachers of science, in general, trained adequately to meet the needs of a diverse classroom? If not, how can this be improved?
- What role can administrators, parents, teachers, and other stakeholders play in ensuring appropriate science education for all students?
- What further studies are needed in order to provide teachers with the tools needed to ensure science success for all students?
- What role should NSTA, along with the Chapters and Associated Groups, have in ensuring appropriate science teaching for all students?
- How do we retain and recruit a diverse group of teachers?
- How can we use partnerships to meet our goals?
- How does current legislation support or limit our ability to ensure equity in science for all students?

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Defining and Preparing Highly Qualified Science Teachers

The demand for highly qualified science teachers is even more pronounced due to the standards set by a variety of national and state organizations and the *No Child Left Behind Act*. What does it mean to be highly qualified? How are teachers prepared to enter today's classrooms as highly qualified teachers?

<u>Background</u>

One of the more recent developments is a move to define quality teacher through the use of descriptive standards. Task forces for the National Science Teachers Association (NSTA) developed and recently revised the NSTA/NCATE (National Council for the Accreditation of Teacher Education) standards for teacher candidates, the National Board for Professional Teaching Standards (NPBTS) developed standards for experienced teachers, while the Interstate New Teacher Assessment and Support Consortium (INTASC) described the qualities a new teacher should possess. The four sets of standards are similar, and together they describe a highly qualified teacher as one who:

- Engages and supports all students in learning;
- Understands child learning, development and motivation;
- Creates and maintains effective environments for student learning;
- Understands and organizes subject matter for student learning;
- Plans instruction and designs learning experiences for all students;
- Uses a variety of instruction and communication techniques;
- Assesses student learning though formal and informal means; and
- Develops as a professional educator while continually reflecting on teaching practices and fostering relationships with colleagues, parents, and the community.

Highly qualified science teachers should have a high level of qualifications both personally and professionally in nature. They should:

- Participate in community activities, especially with those dealing with science, technology and engineering related issues;
- Contribute to science and science education professional associations and publications;
- Deal with scientific social issues through an integration of ideas from science, technology and the humanities;
- Develop instructional competence by remaining current in effective instructional practice, enabling them to change their practice in a desirable direction;
- Possess personal expectations that demand a great deal of themselves along with continual reflection that enables them to adjust their teaching accordingly; will be reflective and adjust their teaching accordingly;
- Be open to suggestions since growth will occur more quickly when they acknowledge the value of feedback from others;
- Orient to change so that when one approach fails to work well, they can speculate on the reasons, select an alternative approach and tri it out;
- Recognize that effective teaching is a matter of constant experimentation and calculated risk taking;

- Demonstrate a strong subject matter expertise along with the more technical knowledge of instruction.

Concerning their relationships with students, they should:

- Model the role of the scientifically literate, actively involved citizen;
- Provide opportunities for students to present competing ideas and resolve problems cooperatively;
- Create an environment that fosters positive attitudes towards the role of science in the world;
- Recognize the inherent worth and uniqueness of individual as students;
- Seek means to encourage full intellectual and emotional development of all students;
- Systematically use mathematics, statistics, and technology in learning and problem-solving activities;
- Form questions that lead to divergent and convergent, inductive and deductive, and metaphorical thinking;
- Design in-depth studies of major issues to stimulate small group discussion of open-ended questions;
- Organize creative and safe use of available resources to equip the instructional program;
- Shift from reliance on textbooks and workbooks to more contemporary venues for seeking information and engaging students in activities;
- Provide current literature for the sciences;
- Make use of informal science education settings;
- Participate in solving local, regional, and global scientific issues;
- Demonstrate the usefulness of science as a process and a means to solve real problems rather than just being a product;
- Distinguish between inference and the empirical reasoning from evidence that is the basis of scientific knowledge;
- Provide familiarity with major themes within the organizational levels of Earth, society and individual;
- Identify the big ideas and overarching themes of the content they are teaching, and develop ways to help their students see the connections;
- Demonstrate an application of conceptual knowledge of science;
- Generate multiple strategies to represent the content to accommodate diverse learners and learning styles;
- Point out the interfaces among principles between and among the sciences, and non-science disciplines;
- Foster effective communication of scientific ideas through oral and written expression;
- Develop an awareness of options for scientific and engineering careers and avocations;
- Collect feedback and assess impact of their program both within and without the formal setting of their schools; and

- Evaluate student progress at the cognitive, attitudinal and psychomotor skills levels using a wide variety of embedded assessment strategies.

The teacher's performance is important, but student performance is more important. Teachers are leaders. They perform in order to get others to perform. Teachers should have a clear understanding as to what they need in order to encourage students to become actively involved in their own learning rather than knowing what they as teachers need to do to, or for, students. They should have the ability to engage students in working on gaining knowledge of science content and processes rather than developing ways of having students passively absorb that knowledge.

In order to guide students in active inquiry and discover, science teachers must possess a deeper understanding of their content, pedagogical content knowledge, students as learners and effective learning and teaching environments. In addition, science teachers should understand and identify productive professional development opportunities, and possess predispositions for continuation of their professional growth and development both in content and pedagogy.

Teaching is a complex practice, not reducible to prescriptions or recipes. Because science is a dynamic discipline, teachers must realize that there is a need to continue to learn about their content, their students and instructional strategies throughout their professional lives.

Discussion Questions:

- How do we prepare them?
- How do we recruit them?
- How do we retain them?
- How do we know if they're highly qualified?
- How do we maintain and enhance quality?
- What is the role of mentoring?
- Should there be differential salaries?
- How does current legislation fit in?
- How can we use partnerships?
- How do we promote inquiry?
- What are the current directions in research?

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Science Education in Our Ever-Shrinking World

Background

A commitment to providing quality science education for all students can be enhanced by providing science teachers with a variety of teaching tools. Both the Standards and Benchmark documents discuss the importance of professional development that provides teachers with the tools for success. For science teachers, new ideas around inquiry, assessment and how they are supported by the research are critical for moving the science education agenda forward.

The search for the new ideas and innovations in practice has traditionally come from a strong, but limited, resource base. Our colleagues in our Boards and Districts within our states and provinces, our chapters and the support from various NSTA resources and their affiliates form a partial list.

With the internet becoming an integrated part of our professional and personal communications, the ability to search widely for ideas and innovation is now a fairly easy task. As science educators break down the distance barrier and share resources, ideas and thoughts electronically, a question that needs to be asked is:

What direction can the National Congress on Science Education give to the NSTA to develop structures to facilitate communication between science educators on an international scale?

This paper will propose a series of discussion questions and provide a brief background on each question. These questions could be used as a guide to an in-depth discussion on the potential directions Congress could give NSTA with regards to facilitating communication between science educators on an international scale?

1. Does the NSTA have a position on International Science Education?

The following position statement was adopted by the Board of Directors in July 1996.

International Science Education and the National Science Teachers Association

Introductory Remarks

The Global Nature of our culture and existence becomes more apparent almost continuously. No longer can isolationism and ethnocentrism take precedence over concern for our planet and, ultimately, our own life quality and survival. Science and education can play a key role in developing such global awareness that leads to appropriate understanding, attitude, and action.

Students must come to see themselves, their learning, and their past and future in a context which includes the entire spectrum of life on earth. Citizens educated in this manner should develop historical and cultural perspective, leading to mutual respect and mutual understanding of the ideas of others.

Declarations

To provide appropriate classroom environments for such learning, our teachers must be educated and informed such that they view themselves, their students, and teaching and learning in a global context. To encourage this:

- NSTA should promote formal partnerships and exchanges with other science teachers and among science teacher associations and organizations worldwide.
- NSTA should promote international conferences, seminars, and sessions fostering global awareness of issues, ideas, and trends in science education;
- NSTA should promote multi-cultural education;
- NSTA should encourage global exchange of information related to science teaching and learning.

Adopted by the
Board of Directors
July 1996

Of note in this position statement is the connection between these themes and themes in other NSTA position papers including multicultural science education and Science/Technology/ Society: A new effort for providing science for all.

2. What are some examples of international communication between science educators?

Professional Organizations

A search of the NSTA website shows 697 sites for the search words international science education. Many of these “hits” are references to international organizations focused on Science Education. Affiliate organizations include the Council for Elementary Science International (CESI), the National Association for Research in Science Teaching (NARST) and the Society for College Science Teachers (SCST). Other international organizations that support science education include International Council of Associations for Science Education (ICASE) and the International Organization for Science and Technology Education (IOSTE).

A common theme of most of these organizations is the post-secondary support. Traditionally post-secondary institutions have embraced and supported communication on a wider scale than K to 12 teachers. In the past part of this may have been for budgetary reasons, but with the advent of electronic communication, the time to explore options for all science teachers may be now.

Journals and Competitions
Journals and various competitions are another way science educators have networked with each other. General Science Education journals like the International Journal of Science Education and Science Education both provide a focus on international science education. Competitions like the Intel International Science & Engineering Fair and the International Physics Olympiad provide opportunities for students and teachers to interact.

On-line Projects
A third aspect of international collaboration can be found in the various on-line science related activities being done by educators world-wide. A good example is the Globe Program. The Globe Program is a U.S initiated program dedicated to hands on science for all students. Students can take measurements of various environmental factors and share this data with other students from around the world. Presently there are at least 102 countries with over a million primary and secondary students in more than 12,000 schools and more than 20,000 GLOBE-trained teachers.

International Assessments
Finally, there are various international assessments that attempt to measure student achievement using an agreed upon framework. The 2003 Trends in International Mathematics and Science Study (TIMSS) is a current example of a large-scale assessment of students in grade 4 and 8 in over fifty countries.

Discussion Questions

- Does the National Congress on Science Education have a role in promoting international science education? If yes, what is that role and the subsequent implications of that role?

Within the context of the above question, factors to consider include:

  - How does the National Congress on Science Education see teaching and learning enhanced by international science education?
  - How can we gain, learn and share from international science education?
  - How can access and the dissemination of relevant information between various organizations be accomplished in a cost effective manner?
  - How can information from international assessments be utilized to improve student achievement?

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http://icase.unl.edu/

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The Globe Program
(http://www.globe.gov/fsl/welcome.html

Trends in International Mathematics and Science Study
http://timss.bc.edu/index.html

How Can Technology Enhance Teaching and Learning?

Background

If any science educator is asked if they need more technology in the classroom and additional training there is a resounding, yes. But, what is this technology? Technology can be described as tools to be utilized by teachers and students to achieve success in understanding the standards.

One question that should be asked is; Is technology a means to an end or and end to a means? When it comes to using educational technology in the classroom, it is important to ask the right questions. We have wanted technology to be a magic bullet that will enable children to have perfect test scores.

Any classroom can have expensive equipment but knowledge of the curriculum and applications will ensure it is used appropriately and not gathering dust. The need for professional development is crucial for the successful integration of technology into the classroom. "The computer as a tool for students and teachers is not going to disappear from our world; not from business, not from home use and not from the school. Yet, even with that knowledge many teachers are still concerned and uncomfortable with finding ways in which a variety of technology-based experiences can expand and enhance what is happening in their classrooms."
Integrating Technology Into The Instructional Process: Good Practice Guides The Way. Marianne Handler/National-Louis University. http://www.ncrel.org/mands/docs/8-3.htm

Even if teachers have the desire to learn how to use technology and incorporate it into their classroom program, research shows that other barriers exist. Findings from the

National Center for Education Statistics indicate that, next to a lack of computers, lack of release time for teachers to learn technologies and lack of class time for students to use computers are barriers to teachers' technology use (Ezarik, 2001).

NSTA has established a position statement for the use of computers, indicating that computers should have a major role in the teaching and learning of science and that computers should enhance, but not replace essential "hands on" laboratory activities. NSTA Position Statement - The Use of Computers in Science Education. Adopted by the Board of Directors January 1999
http://www.nsta.org/159&psid=4

Discussion Questions

- How does technology help us achieve our goals?
- How does one maintain technological literacy in the face of changing technology?
- How do we overcome challenges? (time, money, etc.)
- How do we help teachers meet National Technology Standards (ISTE)?
- How does the Task Force on Professional Development impact on this?
- How does technology enhance access to science education for all?
- How do we use technology to help us assess student learning and progress?
- How can we use partnerships?
- How do we promote inquiry?
- What are the current directions in research?

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Evolving with the Internet: Taking Technology for Granted-Finally. Kristine Mueh, Science Teacher, Centennial Middle School, Boulder,Colorado

http://www.enc.org/focus/change/document.shtm?input=FOC-000705-index,00.shtm
A teacher who has used computers with students for years reflects on how advances in technology have improved its use in the classroom.

K-12 Technology Standards
http://www.mcrel.org/compendium/Standard.asp?SubjectID=19

The Many Facets of Assessment

The Intended and Actual Results

Background
The issue of assessment is growing in intensity and it is a growing concern among teachers. The emphasis placed on the assessment process — high stakes testing of the student population and the designing of instruments that measure the proficiency of teachers and administrators — has severely affected the work of students, faculty, and staff personnel. Each spring in cities across the country, newspapers turn their attention to

state testing programs and in the fall report results from local districts on the front page. What is even more disheartening is the coverage by television stations that dwell on local schools that are considered to be non-performers rather than pointing out the many good programs in these schools. The attention given to standardized examinations prevents many parents/guardians from truly understanding the importance of classroom assessment efforts. Classroom assessment provides a strong impetus for improved teaching and learning. Overall, too much focus is placed on these summative results rather than formative results that give a much more accurate picture of what students are learning.

A favorite story among teachers everywhere is that of the ice cream company president. The president spent hours telling a group of educators how wonderfully successful he had been using only the finest of ingredients for his ice cream. He concluded his talk with the comment that schools should be run like businesses. When he ended his presentation a teacher poignantly asked what he did with the ingredients that were not up to his standards. The president stated that he, of course, disposed of those substandard ingredients. The teacher then pointed out that schools have to work toward educating all of the students not just the prize-winning students. When he heard the auditorium fill with applause he began to understand the major difference between classroom instruction and the business world.

Educators are now “aided” in assessment efforts by “mountains” of literature. A simple search of the word “assessment” on only one of the development laboratories web sites provide 833 different works, reports, and bulletins. There is an army of assessment specialists sharing their formulae for success. Also, numerous testing businesses have been established (often parented by textbook companies) to write questions and prepare and score their test products. School district administrators worry about their own performance evaluations by parent/teacher organizations and school boards. Because school systems are concerned about evaluations, they have become a prime target for the quick sale of “the perfect testing program.” The actual outcomes from the implementation of these stressful structured testing programs often include lower achievement scores and an increasing number of students who are simply dropping out of school.

In the meantime, NCLB is barreling forward, leading the charge of all the state-based legislated assessment plans. Educators understand that a one-shot high stakes test does not provide a proper evaluation of the student’s development or the teacher’s performance. Some educators find themselves defending their efforts to implement inquiry learning and prepare students to be decision makers, critical thinkers and life-long learners. The opponents, often those in administrative positions, are looking for test results that meet the passing standard.

It is important that teachers develop assessment plans that are fair and ensure equity for the students who enter science courses with very different levels of understanding, knowledge, experiences and skills. Unlike high stakes testing, authentic classroom assessments direct student growth and learning, along with guiding instruction The varied assessment tools in a teacher's bag of tricks provide opportunities for evaluation to be one component of a rich learning environment.

Discussion Questions

Assessment! Initial responses by educators to the word itself include:

- Assessment for whom?
  Students? Teachers? Administrators? Parents/Guardians?
- assessment of whom?
  Students? Teachers? Administrators?
- assessment of what?
  Science literacy? Technology skills? Instruction?
- assessment options?
  Authentic? Alternative? Conventional?
- assessment strategies?
  Self-assessment, portfolios, interviews, investigations, presentations, organizers, and
- Why is assessment important?
  How much testing is too much testing?

How should educators begin the assessment process? With some simple questions….

- What is it that my students should know?
- What is it that my students should be able to do?
- What are the criteria for determining success?
- What does student evaluation reveal about my teaching skills?

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What is Our Content Domain?

Examining the Subject Matter We Teach

Background

Determining Our Content Domain or "What should we teach?"

We must determine not only the content science teachers are responsible for teaching, but the best strategy or approach for teaching it and how to make it relevant and connect it to other subjects and life in general.

Content is defined as what students should learn. The National Science Education Standards (1996) go on to outline that the content standards reflect "what students should know, understand, and be able to do in the natural sciences over the course of K–12 education." (p. 6) This statement in itself raises an important point – as teachers we need to not only teach content but also assist the students in "doing" science which encompasses the science process skills and a variety of strategies used to help students construct their own knowledge. Therefore, science educators need to determine not only the science content but also the science processes students should develop in a given course.

<u>How is our content organized?</u>

Perhaps one of the discussion questions in identifying our content domain should be "As educators, why don't we know what our content domain is to begin with?" Because the United States does not have a national curriculum, one of the long-standing concerns has been the lack of coherence and/or agreement on what should be taught at each grade level throughout the country. TIMSS (1997) shows that most science curricula in the United States lack coherence and focus. Furthermore, "most science curricula used in K–12 education tend to overemphasize facts and information while underemphasizing major concepts and 'big ideas.'" (Bybee, 2002, p. 29) The closest thing we have to work from in organizing the curriculum to address major concepts rather than individual facts is the National Science Education Standards (NSES). However, it should be noted that the NSES do not represent a curriculum, but rather a document to help educators "illustrate important features such as emphasis on major ideas, links to meaningful experiences, and uses that are developmentally appropriate for the learner." (Bybee, 2002, p. 29) Although not required, many states have adopted this document whereas other states have developed their own standards, which are similar to, and perhaps, based on the NSES. Even with adoption of this document or the development of individual state standards, teachers within individual districts must sit down and develop their formal curriculum or the way in which the content is delivered.

An area of concern addressed in many reports ranging from the TIMSS Report (1997) to *Before It's Too Late* (2001) is the confusion and frustration felt by educators on how best to deliver the content required. Although educators are told that "less is more" and to "cover depth over breadth" in teaching, there has been difficulty in achieving these goals due to the amount of content still identified in district curriculums. Attempts to provide guidance on how best to deliver the content identified in the NSES have been made in recent years.

Whatever content framework we are using, be it state standards, the NSES, or other documentation, the way the content is organized or the balance and presentation in the classroom is not addressed. This again leaves us with the question of "what do we teach" as well as a new question of "how do we teach it."

<u>Should we cross discipline boundaries?</u>

"The world around us is changing rapidly. There have been changes in how people live, work, and learn. Likewise, the culture and practice of science continue to evolve.

Science is conducted less in bounded disciplines like physics or biology and more in transdisciplinary research fields, of which there are over 400 in the area of biology alone." (Krueger & Sutton, 2001, p. v) Although this statement could be viewed as support for the above question, it is used to introduce a new question for this focus group "Should we cross discipline boundaries and work towards an integrated curriculum?"

As educators, we are constantly pressed for time to accomplish everything in a given year according to our existing curriculums. According to the TIMSS Report (1997), the United States covers science content in an approach that is "a mile wide and an inch deep." We are continually adding new content to the curriculum, but we are never removing content or reorganizing the content. Perhaps the question for discussion then becomes; Can curriculum integration - whether it is within disciplines such as science, or across disciplines such as science, mathematics, and language arts - be a viable alternative to meeting the ever-increasing demands placed on educators. In actuality, this is not a novel approach.

Research shows that there are benefits to breaking down boundaries and crossing disciplines. One of the main supporting viewpoints, this is "transfer of training." "Transfer of training is a technical term used to describe the effects that learning one thing has on the learning, doing, or relearning of another similar thing. (Rowe, 1979, p. 33). There are curriculum designs that help foster the transfer of learning. One of the designs is an integrated curriculum that helps to correlate subject matter areas. The NSES (1996) state "integrated and thematic approaches to curriculum can be powerful; however they require skill and understanding in their design and implementation." (p. 213)

Furthermore, "student achievement in science and in other school subjects such as social studies, language arts, and technology is enhanced by coordination between and among the science program and other programs. "(NSES, 1996, p. 214). An example described in the NSES discusses the coordination between geography (usually associated with a history or social studies requirement) and landforms, which usually falls under an earth and space science standard. It goes on to further explain how oral and written communication skills can be utilized in presentations or sharing of information.

A second example is when we consider "reading, writing, and science should be inseparable [in that] many of the process skills needed for science inquiry are similar to reading skills, and when taught together reinforce each other. (Krueger & Sutton, 2001, p. 52) This does not mean that we can accomplish the teaching of science content within the reading curriculum. It is actually the reverse, cover reading content within the science curriculum. It should be noted that these process skills, although similar in other subjects, are only science process skills when taught within the subject matter of science. (Harlen, 2001).

Classroom implications for science include the integration of writing, speaking, and thinking skills into the science area, even though it is not our content domain. Research has shown that student's skills in reading, writing, and language improve when they utilize it within the science area. If all subject area teachers could come together on an agreement that various skills overlap in the curriculum, there may be a future in utilizing interdisciplinary instruction to accomplish the same goals.

If no other boundaries are crossed, minimally, mathematics and science should be coordinated to “enhance student use and understanding of mathematics in the study of science and to improve student understanding of mathematics.” NSES, 1996, (p. 214) This coordination would best utilize the time constraints of an individual day. However, is also asks that teachers of all disciplines cross their defined boundaries, whether real or imagined, and work together in best meeting the needs of the students.

How do we increase our content domain?

The NSES (1996) have also identified a set of Teaching Standards which are meant to “provide criteria for making judgments about progress toward the vision; [as well as] describe what teachers of science at all grade levels should understand and be able to do.” (p. 27) It is also important that all science educators remain current in their field and to expand their science knowledge. Because as science content is changing daily, it is important to address the question, “How do we increase our knowledge within our content domain.”

Discussion Questions

- How can we use subjects to enhance science?
- How can science enhance other subjects?
- How can we inter-relate subjects to enhance learning?
- What are the connections among the standards?
- How do we keep science subjects relevant to each other and to the outside world?
- How do we know and communicate the value of intra/inter disciplinary teaching?
- What are the implications for professional development, assessment, and the teacher professional continuum?
- How do we promote inquiry?
- What are the current directions in research?
- How does current legislation fit in?
- What are the benefits to the learner if we integrate subjects?
- How can we utilize partnerships to enhance this?

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