Focus Group Report on Draft Frameworks

Introduction

On July 12, 2010, the National Research Council Board on Science Education (NRC-BOSE) released a draft "Framework for Science Education" for public comment (the draft framework is available at http://www.aapt.org/Resources/upload/Draft-Framework-Science-Education.pdf). To respond to this request, AAPT, AIP, and APS organized a Focus Group that met at the AAPT Summer Meeting in Portland, OR, on July 20th. David Heil & Associates was contracted to conduct the Focus Group and prepare the following report that was sent to NRC-BOSE on August 2nd.

The following physics educators and physics education researchers participated in the Focus Group session that was facilitated by Kasey McCracken of Heil & Associates:

Dewey Dykstra
Boise State University

Eugenia Etkina
Rutgers University

Cathy Ezrailson
University of South Dakota

Jack Hehn
American Institute of Physics

Warren Hein
American Association of Physics Teachers

Ken Heller
University of Minnesota

Patricia Heller
University of Minnesota

Ted Hodapp
American Physical Society

Paul Hutchinson
Grinnell College

Jill Marshall
University of Texas-Austin

Robert Poel
Western Michigan University

Gay Stewart
University of Arkansas (by phone)

Emily Van Zee
Oregon State University

As a representative group of the physics community, these participants brought a great deal of expertise in K-12 education as physics education researchers, K-12 curriculum developers, and faculty responsible for K-12 teacher preparation. Their discussion was compiled into the following Focus Group Report on the Draft Frameworks. The report was transmitted to the NRC as a public response to the draft Frameworks. The AAPT Executive Board also used the document as part of their discussions of the draft Frameworks.

NRC Science Conceptual Framework

Discussion Group Meeting Summary – Submitted August 2, 2010

American Association of Physics Teachers (AAPT) Conference Participant Group
Sponsored by:
AAPT, the American Physical Society, and the American Institute of Physics

July 20, 2010

INFORMATION ABOUT GROUP PARTICIPANTS :

The group was sponsored by the American Association of Physics Teachers (AAPT), the American Physical Society (APS), and the American Institute of Physics (AIP); and hosted at the site of the AAPT Summer Meeting in Portland, OR. Participants at the 2010 AAPT Summer Meeting were recruited to participate in a two-hour focus group, moderated by David Heil & Associates, Inc. (DHA). The group included ten in-person participants and one participant who joined the discussion by phone. With one exception (a participant who is staff at APS), the participants are faculty at higher education institutions, primarily working within the field of physics education (researching and developing standards, curricula, instructional strategies, and/or teacher professional development approaches).

	Full Name	**Position (include grade(s) and subject(s) taught)**
Group Facilitator:	Kasey McCracken	Associate, DHA
Group Recorder:	Lauren Seyda	Project Coordinator, DHA

Please organize the group report in the following order:

Question #1 – Vision for Science Education

Although participants recognized that the role of the Frameworks document is to communicate goals for what is to be learned rather than strategies for teaching, most participants believe that the statement for the vision for science education in the document should explicitly address the need for students to learn science every year of their K-12 education. They suggested that, in promoting a vision for science education, this document provides an opportunity to communicate what is known about how children learn and the implications for how we should structure our educational system to teach science. With this in mind, most participants agreed that it is imperative that a statement be included with regard to the importance of visiting and revisiting the science disciplines (including physics) every year throughout the K-12 curricula.

Participants also cautioned the Framework developers to be aware of how information that is presented in the document may be interpreted by classroom teachers or other

educators. While they recognize that the document is not intended to present instructional or curricular strategies, they fear that the presentation of the content within the document may lead educators to continue or to adopt curricular or instructional strategies that they view as ineffective. For example, the use of Cross Cutting Elements could be viewed as an endorsement for interdisciplinary courses. Participants recommended that potential misconceptions by readers be addressed explicitly within the document.

Question #2 – Core Disciplinary Ideas

Participants believe that the Physical Sciences Core Ideas do not adequately present fundamental physics concepts and that the concepts that are presented do not reflect the language of physics. One participant summarized this concern by saying, "each of the sciences, chemistry and physics, has a different way of thinking about the physical world. Forcing them both into the same language and core ideas does justice to neither. It is not that we cannot collaborate at the curricular level, but it is the case that we will not agree at the core ideas level."

With this in mind, participants believe that the document should present separate Core Ideas for chemistry and physics content because these disciplines have very different fundamental principles and discuss the principles using very different language. They find that a more effective approach would be to explicitly define the core ideas for each discipline and then build bridges between the two content areas. As a result of the current format, they find the physics content within the document to be under-represented and inaccurate.

Examples:

- PS1 presents a chemistry view of matter, not a physics view. Physics addresses all different scales of matter, while chemistry is on a very specific scale at all times.
- PS2 discusses *transformations*, a concept which is antithetical to physics. In addition, this statement presents a very narrow view of *interactions* by linking the concept only to *forces.*
- The first part of the statement in PS3 is inaccurate from a physics perspective, unless the clause, "in the universe" is added to the statement. The second part of the statement is incorrect and uses the term "energy availability," which is not used in the discipline of physics.
- The concept of waves, as presented in PS4, is not a core idea of physics. In this Core Idea, the content is presented more appropriately as engineering content (because it discusses ways to investigate nature).

Based on these findings, participants recommended that the Framework developers reconsider the presentation of the physics content in the document entirely. They recommend that the developers reference several key resources as they develop Core Ideas for physics:

The College Board. (2009). *College Board Standards for College Success: Science.* Retrieved, July 23, 2010, from http://professionals.collegeboard.com/k-12/standards.

Heller, P. and Stewart, G. (2010). *College Ready Physics Standards: A Look to the Future* [Available in the upcoming month through http://www.compadre.org under Open Source Physics].

The Heller and Stewart document (2010) is intended to provide an example of the benefits of separating out chemistry and physics content, something that was not done in the College Board Standards (2009).

Question #3 – Cross Cutting Elements

Although participants tended to agree that presenting Cross Cutting Elements adds value to the document, they were unclear on the definition of a Cross Cutting Elements and unsure whether the elements outlined in this document are the highest priority elements. Some participants questioned whether the Cross Cutting Elements were intended as "unifying themes," and suggested that the purpose of these elements be more clearly articulated. They also noted that not all of the elements are at the same level of emphasis (i.e. some are more pervasive across the sciences).

In addition, participants noted that page 1-12 indicates that the cross cutting elements apply across *all disciplines,* and they found this to be an overstatement. They believe that it would be more accurate to indicate that each Cross Cutting Element applies across *at least two disciplines.* For example, they noted that *form and function* does not have a place in physics.

The discussion led participants to question the presentation of mathematics in the document. Although they found the mathematics presented as a Scientific Practice, some participants agreed that it should also be presented as a Cross Cutting Element. These participants noted that "math is a major cross-cutting scientific idea" and that "math is the language of science." These participants found that the essential relationship between mathematics and science merits incorporation of mathematics as both a Cross Cutting Element and a Scientific Practice. There was not consensus on this issue however, in large part because participants did not have a clear and unified vision of what was intended by the Cross Cutting Elements.

Question #4 – Practices

Science Practices. Participants found the presentation of the Science Practices to be outdated. They expressed concerns that this presentation narrowly frames the practices in a way that reflects the traditional view of the *scientific method* (a process of questioning, developing a hypothesis, conducting an experiment, and developing a conclusion), and one which does not reflect the way that scientists work.

Key findings include:

- Predicting and falsifying should be addressed in the Scientific Practices section. Science is about "trying to rule out," as well as supporting. The ability to falsify is the distinguishing characteristic of science.
- Problem solving, although included in the document, is strangely missing from the science discussions. Organized, logical problem solving is the essence of science and must be taught at an appropriate level throughout K-12.
- Although the document states that the practices are not presented in the order that they should occur, the order does imply precedence, and this order could be misleading.
- The document should:
    - clarify that there is no definite entry point into the cycle;
    - indicate how scientists develop questions;
    - clarify the difference between observations and inferences;
    - describe the necessity of proposing multiple hypotheses;
    - cover inductive, deductive, and ontological ways of reasoning;
    - make a clear distinction between explanations and predictions;
    - discuss the use of multiple and independent means of determining; and
    - include a clear statement that science involves evidence.

Engineering Practices. Participants found the treatment of engineering in this document to be very different than the treatment of the science disciplines. They found that the engineering concepts are worded very differently, with a focus on the nature of engineering rather than the process or core concepts related to engineering. They questioned whether this is appropriate. At the same time, participants noted that very few teachers would have the training necessary to teach engineering concepts.

As a part of the discussion of engineering practices, participants noted that an overall weakness of the document is that not enough attention has been paid to the concepts of design and problem solving in the context of science. They found that the engineering practices section appears to be designed to compensate for this weakness, but the unfortunate consequence is that these concepts are presented in isolation from the science content and practices. The group referenced the National Assessment of Educational Progress Framework (NAEP, 2009) as a key source for addressing concepts of design of problem solving.

Question #5 – Prototype Learning Progressions

Note. The group did not explicitly address the questions related to Learning Progressions. This summary is based on comments made during the discussion of the Vision for Science Education.

Participants noted that learning progressions are a contentious area in the field, with some educators, "not believing in them." They also commented that while learning progressions are intended to be evidence/research-based, the field has not yet identified a set of evidence-based learning progressions, particularly progressions that extend from Kindergarten through grade 12. Participants also noted that while the document uses the term *learning progressions* throughout, it is at times referring to concepts that would more appropriately be termed *curricular progressions.* They noted that the document should clarify the distinction between *learning progressions* and *curricular progressions* and ensure appropriate usage of the terms.

Question #6 – General Feedback

Although participants found that a significant amount of work needs to be done to appropriately address the physics content in the Frameworks document, they applaud this important undertaking by the NRC. The participants recognize that this endeavor is difficult. They thank the drafting subcommittee for its work. They would greatly value the opportunity to review a future draft of the Frameworks.

Please submit group report to Tom Keller at tkeller@nas.edu by August 2, 2010.