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## Perspectives: Developing and Defining Both Science and Science Education as Disciplines

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## Perspectives

# Developing and Defining Both Science and Science Education as Disciplines

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The six “domains” have been identified as features for the “doing” of science. These six are: Concept, Process, Creativity, Attitude, Application, and Worldview. They are offered to affect teaching, student learning, as well as a new way of defining science. Concepts and Processes often are the only two typically used to define school and college science content; Creativity and Positive Attitudes are added as two “enabling” domains; a fifth Domain is offered as a focus on the Application of typical concepts and process skills. It is the Domain where and how most people live and operate! The sixth Domain is the Worldview which includes “on-lookers” of the whole science process. This Domain focuses on the philosophy, history, sociology, economics, and psychology of science! Figure 1 is a display of the interactions of these Six Domains of science for needed reform efforts for teaching and assessing student learning – all are important for addressing the meaning of “STEM” for current reforms efforts.

Recent studies indicate that only 0.00004% of all humans across the world are actually practicing scientists, adding to the understandings of the current content and use of process skills (Yager and McCormack, 1989). Unfortunately, most science teachers have never experienced real science themselves – especially with respect to the domains other than Concepts identified by teachers and books.

Following is an elaboration of each of these Six “Domains” indicates the major changes which are needed for reforms of typical K-16 teaching!

**Concept Domain.** Science aims to categorize the observable features of the known universe into manageable units for study often used to describe physical and biological relationships. Part of any science instruction always consists of learning by students of some of the information developed and used by scientists – but with little real understanding of the acts of “doing” science. The concept domain includes: facts, concepts, laws, (principles), and hypotheses and theories being used by scientists. All this vast amount of information is usually classified into such manageable topics as: matter, energy, motion, animal behavior, and plant development. They often indicate current understanding of the universe organized for textbook study (Myers, 1996).

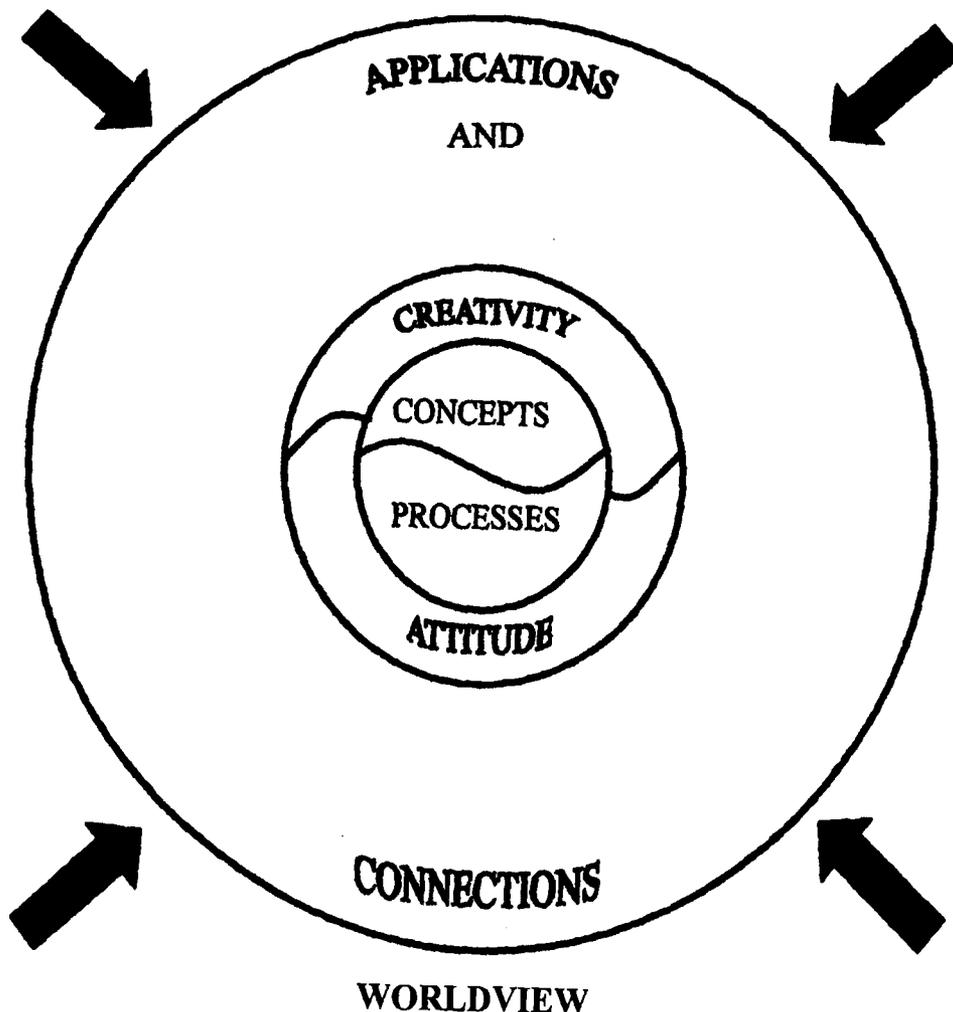
**Process Domain.** Scientists use certain processes (skills). Being familiar with these processes concerning how scientists think and work is an important part of learning science. Some processes of science are: observing and describing, classifying and organizing, measuring and charting, communicating and understanding communications of others, predicting and inferring, hypothesizing, hypothesis testing, identifying and controlling variables,

interpreting data, and constructing instruments, simple devices, and physical models. In the process domain many scientists were attracted to use them – especially when dealing with K-12 science students. In the 60s their skills were offered as important ways to use process as major “reforms” of science teaching (Wilson & Livingston, 1996).

**Creativity Domain.** Most science programs view a science program as something to be done to students to help them learn (?) a given body of information. Little formal attention is typically given in science programs to the development of students’ imaginations and creative thinking. Too often little has been done to encourage curiosity, questioning, explaining, and developing use of testing – all of which are basic ingredients of “doing” science. Some of the specific human abilities important in this domain are: visualizing – producing mental images, combining objects and ideas in new ways, producing alternative or unusual uses for objects, solving problems, and puzzles, designing devices and machines, and producing unusual ideas. Much research and actions have been done on developing student abilities in the creativity domain, but little has been purposely incorporated into instructional science programs – especially in terms of enhancing Creativity (Penick, 1996, p. 84).

**Attitude Domain.** In these times of increasingly complex social and political institutions, environmental and energy problems, and general worry about the future scientific content, processes, and even attention to imagination are not sufficient parameters for an exemplary science program. Human feelings, values, and decision-making skills need to be addressed. This domain includes: developing positive attitudes toward science in general as well as its study of science in schools and the influence on how science teachers can develop more positive attitudes towards the effort themselves (an ‘I can do it’ attitude). They need to explore human emotions; develop sensitivity to, and encourage respect for the feelings of other people. They need to express personal feelings in a constructive way and encourage decisions about personal values and making decisions about social and environmental issues. Interestingly the research is clear. More negative student attitudes form the longer students are enrolled in science courses across the K-12 years (Ali, Yager, Hacıeminoğlu, & Caliskan, 2013)!

**Application Domain.** It seems pointless to have a science program if the program does not include some substantial amount of information, skills, and positive attitudes that can be transferred and used in the everyday lives of students. Also, it seems inappropriate to divorce ‘pure’ or ‘academic’ science from technology. Students need to become sensitized to those



- Concept Domain — The typical focus for traditional teaching (i.e., basic science concepts and skills)
- Process Domain —
- Creativity Domain — The two enabling domains (i.e., questioning & personal engagement)
- Attitude Domain —
- Application Domain — Using concepts and processes in new contexts (i.e., living in the whole world with use of science as defined by the National Science Education Standards (NSES); where most people live and operate when not engaged with science directly)
- Worldview Domain — Examining the philosophy, history, and sociology of the whole science enterprise (i.e., observing science as it operates as a specialized human activity)

experiences they encounter which reflect ideas they have learned in school science. Some dimensions of this domain are: seeing instances of scientific concepts in everyday life experiences; applying learning science concepts and skills to everyday technological problems; understanding scientific and technological principles involved in household devices; using scientific processes in solving problems that occur in everyday life;

understanding and evaluating mass media reports of scientific developments; making decisions related to personal health, nutrition, and life-style based on knowledge of scientific concepts rather than on 'hear-say' or emotions; and integrating science with other subjects in school classrooms. Many in education are looking to technology as a venue for the application of science concepts and the Application Domain itself as a starting point.

Applications of Science courses are becoming vital ingredients in the preparation of new teachers (Varrella, 1996, p. 95).

**Worldview Domain.** Science should portray the full nature of the discipline – not just consist of a study of the current views that characterize the various science disciplines. Often scientists themselves are poor students of what they do, how they do it, and how their discipline changes (and has changed). Many, however, feel a main justification for science in the general education of all students “kindergarten through college” is to portray the nature of science as a major intellectual pursuit of all humankind. This domain is concerned with: the ways in which scientific knowledge is created; the nature of research processes; the meaning of basic concepts of scientific research (e.g., hypotheses, assumptions, controls, replication); the history of the development of scientific ideas; the ways scientists work and organize and work as teams; as well as the interactions among science, the economy, politics, history, sociology and philosophy of science and technology.

Preparing science teachers initially in ways which continue throughout their whole careers is vital and basic to the field of science education. Science teachers must know and use their experiences related to science and technology with all the domains identified.

The six facets of “doing” science are central for the reform efforts of 2013. Unfortunately, however, the 41 member Achieve team responsible for the Next Generation Science Standards (NGSS) decided on Science, Technology, Engineering, and Mathematics (STEM) as a way of succeeding with reforms (NGSS, 2013). They have indicated that the NGSS are not “curriculum”; unfortunately, though, they do not deal with either acts of teaching and/or student learning. This is where Rodger Bybee’s book comes into play (Bybee, 2013). It should be a must in defining the whole of science (and science teaching).

Both are basic for the success of reforms needed in getting more students (and teachers) into the acts of “doing” science itself. It provides ways for getting many of our current teachers to do science, and to verify the importance of illustrating it to students. Bybee’s book is essential for assessing success of STEM reforms of 2013!

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