4-H SET
Science, Engineering & Technology

Executive Summary

Science, Engineering, and Technology (SET) Programming in the Context of 4-H Youth Development

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Clearly, 4-H is at a turning point in its history with an extraordinary opportunity to reaffirm its legacy as a leader in hands-on non-formal science, engineering, and technology education. Since the 4-H Youth Development Program began in 1902, 4-H youth have been engaged in demonstration projects that bring innovation and understanding of land-grant college and university research to local communities. Understanding and appreciating the role of science, engineering and technology is even more critical as the needs of our society and its workforce change. Now, more than ever, we must ensure that our nation's youth develop the necessary competencies and abilities for the United States to remain competitive in the 21st century.

—4-H SET: A Strategic Framework for Progress, May 2007

Background

The National 4-H SET Leadership Team commissioned this paper in October 2006 to identify an established set of nationally-recognized standards in science, engineering, and technology (SET) that 4-H could align with, and a set of life-skill outcomes (SET abilities) that could be addressed with reasonable certainty within the context of 4-H Youth Development.

The report is intended for use by National 4-H SET Leadership Team members and Extension professionals to support the work of state and county 4-H staff and volunteers, and to serve as a framework for design, implementation and evaluation of 4-H programs and curriculum materials. This paper was submitted for blind peer review in April 2007 and approved for publication in May 2007. Suzanne Le Menestrel, Ph.D., national program leader, youth development research, National 4-H Headquarters, CSREES, USDA, conducted the blind peer review.

The full paper will be available at www.fourhcouncil.edu/scienceengineeringtechnology.aspx in July 2007.

Introduction

Existing national science, engineering, and technology (SET) standards have been written with K-12 classrooms in mind, and they naturally rely upon formal delivery methods and content

mastery. However, successful delivery of SET programming must address the total learning experience.

4-H should focus on its greatest strength, that is, non-formal experientially-based delivery methods that address science abilities (process) and science anchors (content) in a hands-on way under the guidance of a trained (scientifically-able) 4-H volunteer.

The Evolution of SET Standards

Current SET standards have roots in the *Science for All Americans* report (1989) and in *Benchmarks for Science Literacy: Project 2061* (1993).

These reports, which describe science content, have served as the beginning point for later reports that formed the basis for current national science standards. The work is significant to 4-H for three reasons:

- It outlines the science standards used for teaching and learning and for curriculum development.
- It recognizes the interconnectedness of science, engineering and technology.
- It emphasizes a shift from separating science knowledge and abilities to integrating all aspects of the science experience, an approach that matches the 4-H experiential model.

In 1996, the *National Science Education Standards* (NSES) were written to shape the way K-12 science is taught nationally. These standards included a new emphasis on process—"science as inquiry"—that requires students to use scientific reasoning and critical thinking to develop their understanding of science content. In 2000, *Inquiry and the National Science Standards* continued to recognize the value of inquiry-based science but gave equal emphasis to activities that address the learning of scientific content.

In 2001, the *Massachusetts Science and Technology/Engineering Curriculum Framework* stated, "Scientific inquiry and experimentation should not be taught or tested as separate, stand-alone skills." In this case, inquiry skills were incorporated into content, an approach that is now included in *Taking Science to School: Learning and Teaching Science in Grades K-8 (2007)*. This document changes the focus from science content and abilities to focus on the learner—what it means to be proficient in science. Content and abilities are incorporated into the discipline of how learners understand and practice science. In addition, core "science anchors" expected to emerge from this effort will be used to manage instruction and to direct professional societies, textbook companies, professional development providers and youth development organizations like 4-H.

Technology Outcomes Within National Science Standards

Existing national technology standards include two very different sets. One set has to do with design, model making, problem solving, controls,

optimization and trade-offs, inventions, and more. The other set emphasizes technology as a way to enhance the teaching and learning process. In NSES, technology is characterized as both the "knowing" and the "doing" parts—emphasizing fundamental understanding about the enterprise of technology and its links with science and the process of design and problem solving.

Engineering Outcomes Within National Science Standards

No nationally recognized engineering standards for K-12 education have been created to date. NSES contain two content standards specific to engineering, which has been and continues to be recognized as a problem-solving and design process within science and technology.

Scientific Abilities Within National Science Standards

Ideally, learners engaged in science content use abilities such as inferring, hypothesizing, measuring, estimating and experimenting to bring meaning to their world. Unfortunately, learning activities often fail to properly facilitate the development of SET abilities in meaningful and significant ways. Learners learn best when actively engaged—physically, mentally and emotionally—within non-formal learning settings. 4-H's challenge is to identify appropriate SET abilities for emphasis within the context of non-formal youth development. To that end, this report identifies 30 of the most recurring abilities cited in today's scientific literature.

4-H SET From an Experiential Perspective

Experiential learning is based on the needs and interests of the learner, uses non-formal learning methods, matches learner interests with adult facilitators, and provides experiences that are organized along a path of experience, reflection,

Generalization and application. In addition, true experiential education includes these overt facilitator interventions: focus, support, feedback and debrief.

Essential Elements—SET Curriculum

An experientially based SET curriculum includes aims, goals and objectives; subject matter; learning experiences and assessment. In addition, three overriding principles are essential:

- engaging resilient preconceptions,
- organizing knowledge around core concepts, and
- supporting self-regulation.

Summary

Based on a review of the literature related to national science, engineering and technology standards, we suggest that 4-H adopt the *National Science Education Standards* as the guiding set of principles for its SET curriculum planning and development process. We also recommend that the 4-H SET Abilities Model put forth in this report be adopted.

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