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A Conceptual Process Model for Improving Youth Science Comprehension

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Abstract: *Improving youth science comprehension in the United States is imperative to reverse current trends in student achievement and to meet an expected shortage of scientists in the future. This lag in achievement scores and need for future scientists is a problem. One challenge is to link inquiry-based learning and experiential education with curriculum designed to improve understanding, skill development, and reasoning abilities to achieve the broader impacts of improved science comprehension. The authors propose a conceptual process model for delivering Extension programs designed to enhance youth achievement in the sciences.*

Introduction

In response to national trends of declining student achievement in the sciences (United States Department of Education, 2009), both formal and nonformal educational efforts have been initiated by the Cooperative Extension Service to remedy this problem. Extension programs like the Memorial Middle School Agricultural Extension and Education Center (MMSAEEC) and 4-H Science are a direct response to this challenge (4-H, 2010; Skelton & Seevers, 2010). However, there is a growing body of research and practice in teaching and learning that suggests inquiry-based learning and experiential education are essential for effective science learning (Blair, Rager, Ostlie, Montgomery, & Carlson, 2004; Bourdeau, 2004; Smith, 2008; Clarke, 2010). This article explores a conceptual model of how inquiry-based learning and experiential education methods facilitate a process by which new knowledge is acquired and new skills are developed by learners, leading to enhanced reasoning abilities and ultimately to improved science comprehension.

Approaches to Teaching and Learning

Traditional teaching methods are not meeting the needs of students entering careers in the sciences (NRC, 1996, 2009). New teaching and learning models are needed to provide students with the ability to engage in scientific inquiry. Inquiry-based learning and experiential education are promising teaching methodologies that promote student learning and affect the engagement of a learner in scientific investigation.

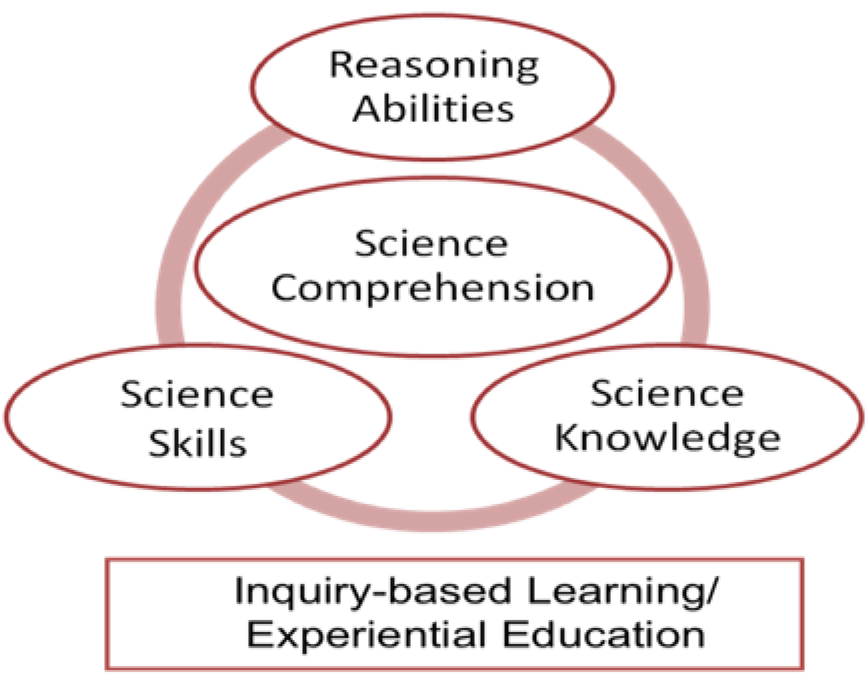
Inquiry-based learning allows students to learn science through investigation. Through science inquiry, students learn to ask meaningful and researchable questions, develop hypotheses, and design experiments. In short, they begin to develop the skills necessary to analyze and interpret data, cite evidence, and communicate findings. This approach has been demonstrated to lead to greater understanding of science (NRC, 2000). Teaching this way is great preparation for future scientists because it matches the scientific method they will employ throughout their career. Through inquiry-based learning, active experimentation lends itself to experiential education.

Experiential education, with carefully designed programs, provides students a range of experiences. Learning by doing provides students with the opportunity to make meaning of content through direct experience (Kolb, 1984). For example, in the analysis of agriculture and natural resource systems, students may investigate specific agricultural or natural resource problems and apply that information to a broader understanding of these systems. Experiential education engages youth in an environment that allows for the development and practice of skills in engaging contexts. It also provides an interactive environment and educational opportunities to engage in discussion with teachers, researchers, farmers, and other practitioners.

Conceptualizing Youth Development and Education Outcomes

Figure 1 depicts a conceptual process model to explain the outcomes that can be achieved through the interactions between each area in the process. Inquiry-based learning guides curricular activities, while experiential education takes place over the long-term course of study. They influence student attitude toward learning by encouraging inquiry into rather than instruction in subject matter. Much of the process, content delivery and skill development, is well understood and well documented in the literature base but their link to reasoning abilities is integral. Otherwise, programs lack meaning and impact.

Figure 1.
A Conceptual Model for Improving Science Comprehension



Inquiry-based learning and experiential education are the foundation for the process. Inquiry-based learning guides short-term curricular activities, while experiential education guides the long-term teaching and learning process. One can conceptualize the process beginning with the acquisition of new knowledge or the building of prior knowledge either through an Extension program or specific Extension curriculum. While learners are acquiring new knowledge, they may also be developing new skills or refining skills. Examples of skill development/refinement include: asking questions, developing research protocols, decision-making, agricultural and horticultural techniques, communicating, and leadership. This process leads to reasoning abilities, where students are able to explain or demonstrate what they did, how they did it, and what they can conclude about the investigation. Through this process a broader contextual understanding is formed, leading to improved comprehension of subject matter and the subsequent re-initiation of the process with new information.

Applications to Extension Programs

MMSAEEC is an Extension youth science center that delivers educational programs in agriculture and natural resources to youth attending Memorial Middle School in Las Vegas, NM. The student population is 89% Hispanic, and the community is underserved. The center meets public education needs and challenges by engaging youth, grades 6-8, in Science, Technology, Engineering, and Math (STEM). STEM-based education is delivered through teaching the principles of sustainable agriculture, natural resource conservation systems, applied science, and other STEM-based topics.

For example, the seventh-grade science curriculum is focused on life science. The organizing theme for programmatic content is agriscience. Students are engaged in the field, in the classroom, and in the greenhouse on topics covering: integrated pest management, food production systems, soil fertility management, genetic diversity and resources, and environmental factors affecting crop growth.

Research into science achievement and leadership skill development through the proposed conceptual model is underway at the MMSAEEC. Tentative findings suggest a promising youth development model with implications for program delivery of 4-H science.

The model can also be applied to nonformal adult education. A Nebraska Forest Service program trained individuals in insect identification to develop a cadre of volunteers to help identify potential outbreaks. Volunteers received training in how to properly photograph insects at a close distance, how to identify signs of insect damage, insect life cycles, and treatment thresholds. Findings from this program suggest that trained individuals were successful in applying what they learned to monitoring forest and tree health (S. Josiah, personnel communication, December 2010).

Conclusions

Extension programs can play a vital role in improving science achievement in the United States. However, programs must use promising teaching and learning methodologies, like inquiry-based learning and experiential education, and go beyond simply delivering content or developing skills to affect science literacy. Using these methods, knowledge must be linked to skill development and reasoning abilities to achieve the broadest understanding by the learners. Stated another way, programs must provide relational and contextual understanding of science, engage learners in the lexicon of science, and use design that ensures learner growth is self-perpetuating.

References

Blair, R. B., Meyer, N., Rager, A. B., Ostlie, K., Montgomery, K. L., & Carlson, S. (2004). Best practices for environmental field days: Structuring your event for fun and learning. *Journal of Extension* [On-line], 42(5) Article 5TOT4. Available at: http://www.joe.org/joe/2004october/tt4.php

Bourdeau, V. D. (2004). 4-H experiential education: A model for 4-H science as inquiry. *Journal of Extension* [On-line], 42(5) Article 5TOT3. Available at: http://www.joe.org/joe/2004october/tt3.php

Clarke, K. C. (2010). A science, engineering and technology (SET) approach improves science process skills in 4-H animal science participants. *Journal of Extension* [On-line], 48(1) Article

1IAW3. Available at: http://www.joe.org/joe/2010february/iw3.php

4-H. (2010). *Science*. Retrieved from: http://www.4-h.org/youth-development-programs/4-h-science-programs/

Kolb, D .A. (1984). *Experiential learning*. Englewood Cliffs, NJ: Prentice-Hall Publishers.

National Research Council. (1996). *National science education standards.* Washington, D.C.: National Academy Press.

National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning.* Washington, D.C.: National Academy Press.

National Research Council. (2009). *Transforming agricultural education for a changing world.* Washington, D.C.: National Academy Press.

Skelton, P., & Seevers, B. (2010). A new Extension model: The Memorial Middle School Agricultural Extension and Education Center. *Journal of Extension* [On-line], 48(6) Article 6IAW5. Available at: http://www.joe.org/joe/2010december/iw5.php

Smith, M. H. (2008). Volunteer development in 4-H: Constructivist considerations to improve youth science literacy in urban areas. *Journal of Extension* [On-line], 46(4) Article 4IAW2. Available at: http://www.joe.org/joe/2008august/iw2.php

United State Department of Education. (2009). *The facts about science achievement*. Retrieved from: http://www.ed.gov/nclb/methods/science/science.html

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