Enhancing Science Education with Engineering and Technology Practices

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Background

Need for Science, Engineering, and Technology Literacy

- National and international assessments have shown low levels of science literacy among school-age youth for the past several decades. No standard assessments of engineering or technology have taken place (NAEP planned for 2014).
- Science, engineering, and technology literacies are required for today's workforce.

Why Engineering & Technology?

- Engineering education may improve science and math learning.
- Scientific inquiry and engineering design differ. Engineering has constraints, tradeoffs, context, practical limitations, and aesthetics.
- New Framework for K-12 Science Education connects scientific and engineering practices.

Role of 4-H Youth Development

- Nonformal education programs provide engineering and technology programs that extend science education.
- 4-H programs promote science, engineering, and technology hands-on learning.

Curriculum Development Process

- Authored by UC Davis faculty and UC Merced students over a ten year period.
- Activities were developed through an iterative process that included pilot testing.
- Content was peer reviewed by engineers, youth development staff, evaluation experts, and by the 4-H National Headquarters.

Promising Practice

Engaging in Science, Engineering, and Technology Practices

The 4-H Robotics curriculum uses robotics as a means of engaging youth and developing interesting and challenging experiences with science, engineering and technology.

Within a module there is a sequencing of activities in three stages.

To Learn (Science) – Activities emphasize exploration and form the foundation upon which youth build conceptual understanding. *Youth explore!*

To Do (Engineering) – Activities build upon the knowledge gained in the exploration phase related to the concepts in the module. *Youth design!*

To Make (Technology) – Activities allow youth to build and test their design while solidifying their understanding of the concepts. *Youth build!*

Junk Drawer Robotics Curriculum

- Focus on science, engineering, and technology practices
- Uses teenagers-as-teachers
- Frames activities in the experiential learning cycle and promotes inquiry
- Promotes small group collaborative learning
- Reinforces engineering design with a youth robotics notebook

Junk Drawer Robotics contains three levels:

1) Give Robots a Hand
2) Robots on the Move
3) Mechatronics

Evaluation & Implementation

Methods for Formative Evaluation 2009-2010

- Implemented with 250 youth at club and afterschool sites in Merced, Santa Cruz, and Kern Counties, California.
- Survey administered at the conclusion of a module.
- N=250; ages 12-14.

Results

- Overall, the formative data seems to indicate the curriculum was well received by adult facilitators in establishing a productive learning environment for science, engineering, and technology.
- Youth rated engineering, on average, higher than science and technology concepts.

Evaluation results for Junk Drawer Robotics Level 1, "Give Robots a Hand"	Module 2 Arms
	Youth respondents n=40
Survey question for youth	Mean Values*
The lesson/activity helped me to learn about science or science concepts.	3.25
The lesson/activity helped me to learn about technology or technology concepts.	3.56
The lesson/activity helped me to learn about engineering or engineering concepts.	3.69
The lesson/activity helped me to learn about mathematics or math concepts.	3.62
I found the lesson or activity to be interesting.	3.55
I would tell my friends that the activity was a good one.	3.36

* *Means are from Likert response values: 1-Strongly Disagree; 2-Disagree; 3-Neutral; 4-Agree; 5-Strongly Agree*

Implementation

- Curriculum is published by the National 4-H Council as part of a three track robotics program which also includes *Virtual Robotics* and *Robotics Platforms*. and available on their website for purchase. Curricula is being implemented across the country in 4-H and afterschool programs.
- http://www.4-h.org/resource-library/curriculum/4-h-robotics/

Mahacek, R. & Worker, S. (2011). Extending science education with engineering and technology: Junk drawer robotics curriculum. In A. Subramaniam, K. Heck, R. Carlos, & S. Junge (Eds.), *Advances in youth development: Research and evaluation from the University of California Cooperative Extension 2001-2010* (pp. 46-57). Davis, CA: University of California Agriculture and Natural Resources. Retrieved from http://www.ca4h.org/Research/CYD/Publications/

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