

Engineering Our Future New Jersey Elementary School

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Abstract

Engineering is Elementary (EiE), developed by the Boston Museum of Science, is a set of curricula that integrate engineering and technology concepts and skills with elementary science lessons. Each *EiE* module contains lessons that integrate an elementary school science topic with a specific field of engineering and features hands-on activities that engage students in the engineering design process.

Two modules, *Water, Water, Everywhere* (environmental engineering) and *Catching the Wind* (mechanical engineering) were implemented in 12 elementary schools in New Jersey as part of the Engineering Our Future New Jersey (EOFNJ) project². EOFNJ is a collaboration between Stevens Institute of Technology's Center for Innovation in Engineering and Science Education (CIESE), the Museum of Science, Boston, and other public and private partners. In October 2003, the New Jersey Department of Education released new Core Curriculum Content Standards that, for the first time, require technology education to be taught K-12⁴. The goal of the project is to ensure that all New Jersey students—from elementary through high school—experience age-appropriate pre-engineering curriculum activities as a core part of their educational experience and that pre-engineering curricula become a required component of elementary, middle, and high school education within the next five to 10 years.

This paper will provide an overview of the elementary level (grades 3-5) pilot program. Since the data from the pilot study is not yet available, this is a work in progress.

Introduction/Background

From January - June, 2006 twelve New Jersey elementary teachers from a diverse range of schools across the state of New Jersey implemented the two *EiE* units described below. Approximately 450 third and fourth grade students participated in the program. The teachers attended two full-days of professional development at Stevens Institute of Technology in December 2005 and beginning in January 2006, implemented the pre-engineering curriculum in their classroom with assistance from CIESE staff. The purpose of this pilot program was to assess the impact of the use pre-engineering curricula, specifically the *EiE* materials, on student understanding of technology and engineering concepts. Researchers at the Boston Museum of Science's National Center for Technological Literacy provided previously developed pre and post assessments.

Engineering is Elementary Materials

Currently, eight *EiE* units have been published and there are thirteen more in various stages of development¹. Each unit takes place in a different country and features a science topic paired with an engineering field and a design challenge. A storybook introduces basic engineering content and the related science topic and highlights the engineering activities that children will do. Each story is narrated by or features a child as the main character who works with an engineer to solve the design challenge. The boy or girl uses the engineering design process to create his or her own solution to the challenge.

All units begin with a preparatory lesson entitled “What are Engineering and Technology?” Before the students begin the design challenge, and the teacher introduces the five step engineering design process: Ask, Imagine, Plan, Create, Improve.

The teachers’ manuals include:

- Background information for teachers.
- Lesson plans with detailed instructions for teachers.
- Duplication masters with student handouts and assessments.

The two units described below were selected for use in the EOFNJ pilot study because they fit best with the NJ Science and Technology Standards 5.1-5.4 (Science)⁵ and 8.2 (Technology)⁶. All pilot teachers completed both units including the pre and post assessments.

- ***Water, Water, Everywhere*** (Environmental Engineering)
The storybook is narrated by Salila, an Indian girl who lives near the Ganges River. This unit addresses the increasingly important issue of water quality through lessons that teach students about water contamination and the ways that people ensure the quality of their drinking water. The science content focuses on the water cycle and the properties of water. Students plan, construct, test, and improve their own water filters.
- ***Catching the Wind*** (Mechanical Engineering)
The storybook narrator is Leif who lives in Copenhagen, Denmark. This unit guides students to learn about wind and the ways engineers design machines to capture wind energy. The science content focuses on air and weather. Students explore and conduct tests to determine which materials and shapes are conducive to catching the wind. For the design activity, students create their own windmills that can lift a small weight.

Evaluation

The assessments developed by the Informal Education and Evaluation Department at the Boston Museum of Science are designed to test the effectiveness of the *EiE* curriculum and to answer the question: Do students who have used *EiE* curriculum show gains in their understanding of engineering technology?

The most recent research by Boston Museum of Science found that students who use *EiE* materials make significant gains on their knowledge of engineering/technology concepts³ As of this date the information from the EOFNJ pilot study has been compiled and entered into a data base which is now being analyzed by the designers of the assessments.

The New Jersey data will be added to the above study which now includes information from over 3,000 students from Colorado, Florida, Minnesota, and Massachusetts in grades 3-5.

The New Jersey student assessment data will not be available until mid-November 2006. However, CIESE staff has collected the reflections and observations of the teacher participants using informal surveys and classroom visits. Anecdotal data and a cursory inspection of teacher responses indicate the following:

- Teachers discovered that engineering concepts can be introduced at an early grade level. They reported that their students developed a better understanding of what engineers do.
- Teachers found that the *EiE* lessons furthered their objectives for science in the classroom and reinforced concepts taught in class. Their students' understanding of science concepts improved as a result of interaction with the *EiE* materials and they plan to integrate the *EiE* lessons into their existing science curriculum.
- Both the teachers and their students felt comfortable using the engineering design process; students learned that there are different ways to solve problems. Students were active learners and motivation was positively affected; they were engaged and excited.

Future Plans

CIESE, through pilot studies such as this, aims to demonstrate the need, the value, and the impact of pre-engineering education on elementary, middle, and high school students.

Plans for 2007 include:

1. Identifying training partners to deliver teacher professional development throughout New Jersey and preparing trainers.
2. Identifying recommended curriculum materials and implementation strategies for elementary, middle, and high school.
3. Providing orientation and technical assistance workshops for school districts to learn about EOFNJ, curriculum requirements, curriculum materials, assessments (existing and expected), and professional development opportunities.
4. Investigating other pre-engineering curricula that support the NJCCS in Science, Math and Technology.

Currently CIESE, funded by a grant from the Verizon Foundation, is offering professional development in using the *EiE* materials. The following units will be added in January, 2007.

Sounds Like Fun! (Sound & Acoustical Engineering)
An Alarming Idea (Electricity and Electrical Engineering)
Just Passing Through (Organisms and Bioengineering)
The Best of Bugs (Insects & Agricultural Engineering)

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Biography

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