

# Chapter 12

## STEM Outreach with the Boe-Bot®

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### ABSTRACT

*Science, technology, engineering, and mathematics (STEM) education has come to the forefront as national and state leaders look for ways to foster innovation in the United States. Innovation is the key to maintaining economic and national security, and it is through the application of math and science concepts that scientific and technological innovations are developed. By increasing student interest and motivation to pursue studies in STEM fields, the odds of developing and sustaining a workforce capable of creating the innovations of tomorrow increase. Students need opportunities to explore STEM concepts in contexts that demonstrate the relevance of those concepts in the world around them. This chapter describes the rationale, development, implementation, and outcomes of a STEM outreach robotics activity that uses the Parallax Inc. Boe-Bot® kit as a platform. It is intended to provide an example of how robotics and STEM concepts can be integrated into a project that engages students in problem solving and teamwork, while addressing content standards through student-centered learning. Systems engineering principles were used both in the development and the implementation of this robotics STEM outreach activity.*

### INTRODUCTION

Innovation is the cornerstone that established the United States as a world leader and continues to enable our country to maintain its technological and competitive edge in an increasingly global economy. The national STEM Ed Caucus recognizes that the “foundation of innovation lies in a dynamic, motivated, and well-educated work force

equipped with STEM skills” (2005). However, recent trends show that the educational system in the United States is failing to produce graduating seniors who are academically equipped to pursue degrees in STEM fields (Committee on Prospering in the Global Economy of the 21<sup>st</sup> Century, 2007). In an effort to counteract these trends, organizations with vested interests in attracting students to STEM fields have been involved in sponsoring and developing STEM outreach programs.

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The robotics activities described in this chapter were developed and field-tested at the Air Force Research Laboratory (AFRL) La Luz Academy—a STEM outreach program conducted at Kirtland Air Force Base, in Albuquerque, New Mexico. This program is run through a Cooperative Agreement between the AFRL and the New Mexico Institute of Mining and Technology (NM Tech). The goal of the AFRL La Luz Academy is to generate student interest in STEM concepts and career fields, and to motivate students to pursue future STEM studies. The program provides unique hands-on activities that are designed to be relevant to students’ interests while providing opportunities to apply STEM concepts.

Scientist and engineer partners from the AFRL are an integral part of the development and implementation of the activities that comprise the program. The planned evolution of the AFRL La Luz Academy, as well as the development of each individual “flight”, occurred using a systems engineering methodology to guide collaborations between AFRL scientists and engineers, and educators. This approach resulted in a program that provides a variety of STEM activities that are cohesive, flexible, relevant, and continually improving.

The AFRL La Luz Academy program started in 1994 with the implementation of two high school activities and, over sixteen years, evolved to include five distinct “flights” for students in grades five through twelve. Each flight was designed to meet specific objectives aimed at sparking student interest in STEM and related career fields. For example, the Mars Missions Flight involves elementary school students in the planning and implementation of a simulated manned mission to Mars, while the high school STEM Challenge Flight provides a systems engineering framework for students to use in developing and implementing their own year-long STEM projects. Hands-on activities are designed to provide real-world connections to STEM concepts, many of which carry over from flight to flight. This allows students

who participate in the program over multiple years to understand that STEM concepts can be applied in different situations to produce a wide variety of results.

The Intro to Systems Engineering Flight described in this chapter is the most recent of the AFRL La Luz Academy flights. The activities that comprise the flight introduce middle school students to systems engineering concepts through the application and integration of STEM concepts as they relate to beginning computer programming and robotics while generating student interest and motivation to pursue STEM studies and career fields. The chapter is organized to include a background on the need for STEM outreach; a literature review of the research supporting informal outreach as a means to motivate students and increase their interest in STEM fields; a description of the methodology and rationale used for the development and implementation of the robotics activities for the flight; a discussion of connections between specific student activities and STEM concepts; and a summary of outcomes and future research directions.

## **BACKGROUND**

The 2007 report *Rising Above the Gathering Storm* raised concerns about our nation’s ability to produce the number of scientists and engineers required to allow our country to maintain its competitive edge (Committee on Prosperity in the Global Economy of the 21<sup>st</sup> Century, 2007). The shortage of students pursuing both STEM degrees and careers in STEM fields is linked to many factors; one of those factors is a lack of student interest in STEM. To improve student interest in STEM fields, Mike Anderson, Chief Scientist, the PTR Group, Inc., recommends that we “show our youth that STEM-related subjects are interesting and important” (Anderson, 2010).

Low student interest in STEM fields may be related to a lack of opportunities for students to

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