Providing STEM Experiences Through Robotic Competitions for Students and Teachers Grades 6-12.

Steve Williams

Department of Engineering and Technology Education

Utah State University, Logan, UT

Introduction

Science, Technology, Engineering, and Math (STEM) is a current emphasis in education. Machi (2009) points out that "in order for the United States to be globally competitive, innovative, and prepared for new economic and security challenges, the U.S. must have a competitive and innovative educational environment that encourages entrepreneurship and excellence in STEM subjects" (p. 1). The U.S. government depends on science, technology, engineering, and math to maintain its position as the world superpower (Machi, 2009, p. 2) and spends "about $700 million a year on elementary and secondary education in the STEM fields through agencies such as NASA, the National Science Foundation and the U.S. Education Department " (Nick, 2010, p. 1). "Every day, a new technology is brought to market by the STEM workforce, enabling people around the world to live longer, better lives (Machi, 2009, p. 2)." From the digital cable box used to watch TV shows to the micro-processor in your car that performs self diagnostics and e-mails the results, technology is used in almost every part of our daily lives

In October 2007 with the launching of Space Shuttle Discovery, NASA showed their interest is attracting students into the STEM areas by hosting an educational forum entitled “Attracting Top-Performing Students to STEM Education Programs and Careers" (Farmer, 2009, p. 42). The main motivator for this conference was "not enough students have chosen science,

technology, engineering or math (STEM) tracks in college, so it's more difficult to find the necessary engineers, chemists, programmers and pilots required to propel the space program to new heights" (Farmer, 2009, p. 42).

Implementation of STEM curriculum is a major challenge in the public school systems around the country. Machi (2009) points out that "schools across the U.S. place more emphasis on extracurricular activities than on STEM education. In many schools, there are multiple fundraising activities for sport teams but few for science fairs or math competitions" (p. 2). A second challenge is scheduling around other activities in which student are involved. This can cause the students to choose which extracurricular activity they are interested. To address this issue the department of Engineering and Technology Education (ETE) at Utah State University (USU) implemented the Design Academy with an open-entry, open-exit format, to provide an extracurricular STEM academy for students in grades six through twelve. This format allows students to attend the months when they are not enrolled in a conflicting activity such as seasonal sports.

This paper focuses on the USU Design Academy and its purpose to provide STEM experiences through robot competitions for students and teachers grades 6-12. Specifically, it will address one major objective of the Rocky Mountain NASA Space Grant Consortium to "provide pre-college teachers with information and hands-on materials and experiments to enhance student enthusiasm about STEM learning" (Rocky Mountain NASA Space Grant Consortium).

The Design Academy

To address this need for the implementation of STEM curriculum the ETE department at Utah State University has started the USU Design Academy. The USU Design Academy was

founded on four major objectives: first, to provide students with an environment where they can be introduced to and learn STEM concepts and corresponding career paths, second, to provide a platform for the development and piloting of curriculum for teachers regionally and nationally, third, to provide opportunities to underrepresented populations in the STEM content areas, and fourth, to establish research capabilities for external funding to study STEM learning.

In order to provide students with an environment where they can be introduced to and learn STEM concepts and corresponding career paths the Design Academy considered and addressed constraints that have hindered participation previously in such programs. For example, due to the vast selection of extracurricular activities and active student schedules, the Design Academy's curriculum is performance based utilizing an open-entry open-exit format. Skill sets, similar to merit badges (see figure 1), have been established that students earn as they progress through the curriculum. This format allows students to progress at their own pace and to attend when their schedule permits.

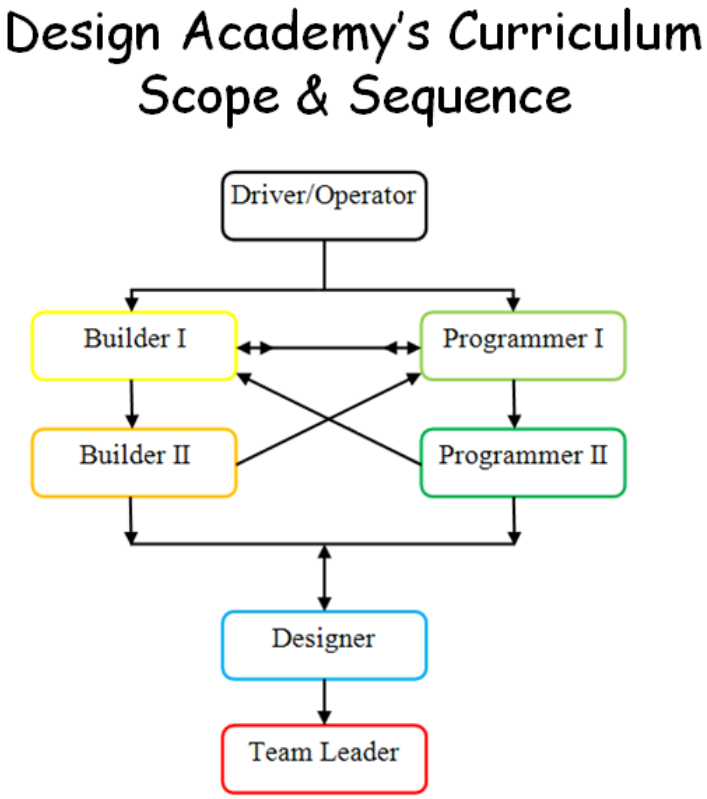

Figure 1: Each bubble represents skill sets students achieve as they progress through the curriculum.

Currently, the curriculum focuses on VEX robotic competitions as the STEM content area. Johnson (2010) points out that "competitive robotics as an interactive experience can

increase the level of student participation" (Johnson 2010, p. 16). In the Design Academy students learn how to design, fabricate, and program competitive robots. In addition, they have the opportunity to become a member of a competitive team. Teams compete at the regional level with winning teams advancing to the international level.

One of the Rocky Mountain NASA Space Grant Consortium objectives is to "provide pre-college teachers with information, hands-on materials, and experiments to enhance student enthusiasm about STEM learning" (Rocky Mountain NASA Space Grant Consortium).
The academy operates for students in Cache Valley, but has an outreach program to help other areas in the region and to provide regional competitions. On January 9, 2009 the academy held the first annual USU VEX robotics regional competition in the Engineering Building at USU. In preparation for this competition, a formal workshop was held for eight teams from the state of Utah. Through a partnership with the 4-H, these participants were provided a basic robot kit and training on construction and programming, with an additional workshop held at Westlake high school in Saratoga Springs. Prior to the competition another workshop was held at USU to further prepare the teams to compete successfully. Ten teams from Utah and Idaho competed for the chance to advance to the international competition level. Three qualified to attend the Vex Robotics Championship of America in Omaha, Nebraska, and the VEX World Championship held in Dallas, Texas.

One major focus of the Design Academy is to provide a platform for the development and piloting of curriculum for teachers regionally and nationally. Curriculum is being developed and piloted in the academy that can be distributed to any teachers and schools who wish to use it. Also the mentors, instructors, and assistants for the Academy are students enrolled in the Engineering and Technology Education program at USU. Upon completion of their degree,

mentor students will be prepared to implement a STEM program into their schools. These mentors participate in the development and piloting of curriculum that can be taken with them and used in the classroom they teach.

In the STEM areas females are an underrepresented population. It was a struggle to encourage female students to attend the academy. To address this need to encourage female participation the Design Academy suggested tuition scholarships as a possible tool to attract interested females. The Rocky Mountain NASA Space Grant Consortium agreed to provide tuition for four female students. As a result four females enrolled in the Design Academy and will be competing in the Utah Vex Regional competition in June.

A research emphasis has been placed on the Design Academy allowing for external funding to study STEM learning in grade 6-12. The students in the Design Academy can participate in studies related to learning STEM concepts. As an example of the research ideas currently in development, a study can be conducted to determine if students are more motivated to learn STEM concepts when working with robotics rather than working in a traditional classroom. This research can provide information to help increase students STEM learning.

Conclusion

The Design Academy is focused on addressing the need for implementation of STEM curriculum. Current deliverables of the Design Academy include, but are not limited to, the following:

- Establish after-school educational opportunities for students to learn STEM concepts through robotics.
- Develop and pilot curriculum that can be used in schools regionally and nationally.
- Hold formal workshops to train students and teachers from Utah and Idaho.

- Organize and operate future VEX robotics regional competitions in the state of Utah.
- Mentor teams in the region who continue on to the VEX World Championships.
- Participate in the operation of the Technology Student Association (TSA) VEX competition in Utah

These deliverables help to meet the four objectives of the Academy, i.e. providing students with an environment where they can be introduced to and learn STEM concepts and career paths, providing a platform for the development and piloting of curriculum for teachers regionally and nationally, providing opportunities to underrepresented populations in the STEM content areas, and establishing research capabilities for external funding to study STEM learning.

.

References

Nick, A. (2010). Obama plans $250 million initiative for science, math. *The Washington Post*, Retrieved from Newspaper Source database.

Farmer, T. (2009). A STEM Brainstorm at NASA. *Techniques: Connecting Education and Careers*, *84*(1), 42-43. Retrieved from ERIC database.

Rocky Mountain NASA Space Grant Consortium (2010). About the Rocky Mountain NASA Space Grant Consortium, from http://spacegrant.usu.edu/about.php

Machi, E., & Heritage, F. (2009). Improving U.S. Competitiveness with K-12 STEM Education and Training. Heritage Special Report. SR-57. A Report on the STEM Education and National Security Conference, October 21-23, 2008. *Heritage Foundation*, Retrieved from ERIC database.

Johnson, R., & Londt, S. (2010). Robotics Competitions. *Tech Directions*, *69*(6), 16-20. Retrieved from Academic Search Premier database.