Work in Progress - United States Coast Guard Academy Robotics on Water Competition as Recruiting Tool – Program Enhancement for STEM & Diversity Outreach

Brian Maggi, Hudson Jackson, Kassim Tarhini, Jonathan Russell
United States Coast Guard Academy, Brian.J.Maggi@uscga.edu, Hudson.V.Jackson@uscga.edu, Kassim.M.Tarhini@uscga.edu, Jonathan.C.Russell@uscga.edu

Abstract - Over the past two years, the United States Coast Guard Academy developed and implemented a one-day hands-on Coast Guard Academy Robotics On Water program (CGAROW). The program is gaining national attention because of its success in recruiting a diverse group of students interested in pursuing Science, Technology, Engineering and Math (STEM) careers in the Coast Guard. In order to meet the growing interest from high schools to host the program, USCGA is standardizing the materials and equipment used in order to make them readily available. Furthermore, to advance CGAROW’s role as a STEM outreach program, educational materials are being developed to reinforce STEM concepts within the current middle and high school curricula. The authors discuss the ongoing enhancement of the CGAROW program, its standardization and curriculum development.

Index Terms – Outreach, Robotics, Science, Technology, Engineering, Mathematics.

INTRODUCTION

There is a general need for the United States to produce more engineering, science and technology graduates to meet the global demands of the respective industry. The latest census shows change in demographics that will increase the urgency for higher education to attract and retain students from diverse backgrounds to ensure that the student population is more reflective of the American society. As the Coast Guard Academy’s newest diversity outreach program, the Coast Guard Academy Robotics On Water (CGAROW) program has earned significant recognition for creating awareness and interest in the Coast Guard and Coast Guard Academy while promoting Science, Technology, Engineering and Math (STEM).

The main goals of the CGAROW program are to introduce middle and high school students to STEM concepts through a hands-on project; and to expose them to the missions of the Coast Guard for the purpose of recruitment. The focus of the program is outreach to schools with diverse student populations. A typical one-day program held at the schools involves dividing participants (maximum 30) into teams of 3-5 students. Each team receives a plug-and-play robotics system, descriptive handout, several parts and is tasked with designing and building a radio controlled floating robotic craft for use in a competition simulating Coast Guard operations. The program consists of three phases: general education or familiarization, design and build, and competition. The goal of the education phase is to have students familiarize themselves with the program objectives, and the operation or functions of the various parts provided. In the design phase students are required to build a floating robot and modify available components to complete the required tasks in the competition. During the competition, each team must, in four minutes, use their craft to complete as many Coast Guard mission oriented tasks as possible in a 3 meter by 3 meter pool.

Since the successful pilot implementation in March 2009, CGAROW has been hosted at seven schools throughout the country including New London (CT), New York City, Miami, Baltimore, Tampa, Hartford, and El Paso. The responses from participants have been overwhelmingly positive. This has resulted in the establishment of outreach partnerships with schools and student exposure to the Coast Guard Operations and STEM careers. CGAROW is currently undergoing modification to include STEM based educational materials, standardization of the equipment, and an additional mentoring component. Each new aspect of the program is discussed in the following sections.

CURRICULA DEVELOPMENT

CGAROW is an exciting and well-received hands-on activity which if effectively implemented may improve the teaching of science, engineering, technological and mathematical concepts within the current middle and high school curricula. Based on feedback from the two most recent competitions in El Paso, TX and New London, CT 98% rated their experience as positive. Additional survey results shown in Figure 1 indicate that 98% of the participants agreed that CGAROW provided hands-on exposure to STEM concepts, and 85% felt the program sparked their interest in STEM courses. After reviewing numerous comments from both students and teachers, it was
felt that developing educational or curricula material for CGAROW will enhance the impact of the program on students interested in pursuing STEM careers. Therefore, providing grade level appropriate educational material prior to an event, will better prepare students to effectively compete and apply the STEM principles learned in the classroom.

The goal of the curricula development component is to use the design and competition phases of CGAROW to emphasize the hands-on demonstration of STEM principles and concepts. The educational material will be developed within the context of the existing middle and high school STEM curricula. In trying to meet this goal, the following will be addressed: (1) Review of the current middle and high school curricula to assess where key concepts of CGAROW should be incorporated, (2) revision of the equipment inventory, and (3) selection of three schools for pilot implementation.

The first opportunity for input from teachers will be this summer during USCGA’s 3rd Annual Engineering Challenge for the 21st Century Teacher enrichment program. This program is a weeklong STEM focused experience with participants from middle schools, high schools, community colleges, and college outreach programs designed to enhance the effectiveness of teachers in recruiting and retaining STEM students. Working together with this diverse group of school teachers and college faculty is a key component to the curricula development. The insight and perspective provided by each member of the group will ensure successful integration. In a follow up to the enrichment program, two faculty members from USCGA will be partnering with faculty members of multiple Historically Black Colleges & Universities (HBCUs), middle and high schools to further improve the curricula materials and methods of implementation.

- **STEM INFLUENCE**
  - Provided Exposure
  - Sparked Interest
  - Pursuit of a Career

<table>
<thead>
<tr>
<th>%</th>
<th>Yes</th>
<th>Maybe</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1 – Summary of Survey Results**

**STANDARDIZATION – CGAROW IN A BOX**

There is significant planning and time required to successfully run a one-day CGAROW competition. Preparation includes purchasing the necessary VEX products, customizing them, and including other materials needed to build six water crafts placed into individual kits. Depending on the competition location, these kits are either shipped or transported in 8 large pelican cases weighing about 100 lb each. The self-sufficiency of the program makes it appealing to hosting venues, but due to resource limitations the Coast Guard Academy has been able to support only four competitions per year.

Most of the equipment currently used has been customized by CGAROW staff to meet the competition guidelines and time constraints. This is one of the factors limiting the expansion of the program. USCGA is therefore exploring options to develop a more compact, standardized and readily available kit - “CGAROW in a box”. VEX, a company that manufactures the majority of the materials used in CGAROW, is interested in partnering with USCGA to develop the new kits and promote the competition. VEX will host CGAROW at its World Championships on April 14-16, 2011. CGAROW staff also plans to visit the VEX manufacturing site this summer to assess the capabilities of the plant and determine how to standardize the build kits and competition pool. With CGAROW in a box and the curricula materials, middle and high schools will be able to run the program independent of USCGA.

**MENTOR DEVELOPMENT**

This one-day CGAROW event has benefited USCGA cadets by providing mentoring and leadership opportunities to lead teams in the development, design and building process. If the CGAROW program grows with the standardized kits and curricula development, the natural progression will be to take advantage of this mentorship opportunity. USCGA is proposing to start a “Mentor Academy” during the summer where university engineering students work alongside USCGA cadets. During this mentoring academy, students will receive training on behavior styles, leadership and mentorship. The overall goal is to “energize” and provide enthusiastic engineering students with the tools needed to run their own CGAROW competitions and become leaders in STEM outreach programs in their local communities.

**CONCLUSIONS**

The one-day outreach CGAROW program has been relatively successful in recruiting students from diverse background interested in STEM careers within the Coast Guard. Although there has been significant interest from schools to host the program, the outreach has been somewhat limited because CGAROW is solely managed by Coast Guard staff. Standardization of the equipment will make CGAROW more accessible and enable schools to independently organize the program. Furthermore, the inclusion of educational materials will provide middle and high school teachers an additional tool to reinforce STEM concepts and principles.

**AUTHORS INFORMATION**

Brian Maggi, LCDR, Assist. Prof, United States Coast Guard Academy (USCGA), New London, CT
Hudson Jackson, Assistant Professor, USCGA
Kassim Tarhini, Lecturer, USCGA
Jonathan Russell, CAPT, Professor, USCGA

978-1-61284-469-5/11/$26.00 ©2011 IEEE

October 12 - 15, 2011, Rapid City, SD

41st ASEE/IEEE Frontiers in Education Conference

SID-2