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## CyberPatriot: Exploring University-High School Partnerships

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### ABSTRACT

*Since its inception in 2008, the CyberPatriot competition has been held annually with the goal of increasing the number of technologically skilled individuals working in the field of cybersecurity. The competition is designed to address the shortage of U.S. citizens with degrees in science, technology, engineering, and math (STEM) disciplines by encouraging talented high school students to pursue post-secondary study leading to careers in cybersecurity. This paper describes how one university successfully partnered with a large metropolitan high school district to better reach out to talented students in both traditional and underrepresented groups.*

**Keywords:** IT skills, CyberPatriot, cyber security, national security

### INTRODUCTION

President Obama has said that “America's economic prosperity in the 21st century will depend on cybersecurity” (The White House, Office of the Press Secretary, 2009). According to a Report of the CSIS Commission Cybersecurity for the 44<sup>th</sup> Presidency, “For at least the past six years the U.S. Department of Defense, nuclear laboratory sites and other sensitive U.S. civilian government sites have been deeply penetrated, multiple times, by other nation-states” (Evans & Reeder, 2010, p. v). The dependence on computer systems and the need for secure computer systems compels government, private industry, and academia to determine how they are going to hire personnel, train existing personnel while staying abreast of new exploits.

At the same time, the shortfall in skilled workers in the area of cyber security is well documented. The Bureau of Labor Statistics states that the field of Computer and Information Technology is projected to grow by 22% from 2010 to 2020. The report further states that “workers in these occupations will be needed to develop software, increase cybersecurity, and update existing network infrastructure” (United States Department of Labor, Bureau of Labor Statistics, 2012). However, Jim Gosler of the Energy Department's Sandia National Laboratory in Albuquerque, New Mexico indicates that there are only about 1,000 security specialists with

the right skills to be effective in securing computer systems but that the United States needs about 10,000 to 30,000 individuals (Gosler, 2010).

To help bridge this gap, the Air Force Association conceived of the CyberPatriot competition in 2008 with the goal of increasing the number of skilled individuals working in the field of cyber security (Air Force Association (AFA). 2012). The competition reaches out to talented high school students by getting them excited about cyberspace and issues related to securing it. There are two categories of competitors: an all-service division for junior ROTC and civil air patrol and an open service division for everyone else.

CyberPatriot is designed to encourage competition in cyber security by allowing high schools to enter teams directly into the games. Teams are limited in size from two to five students with each school allowed to submit multiple teams. From its first round of competition in 2009, CyberPatriot has grown dramatically. The most recent competition, CyberPatriot IV, concluded in March 2012 with 1,014 student teams from across the country (Commonwealth of Virginia. Office of the Governor, 2012).

This paper explores how one university was able to successfully partner with the Los Angeles Unified School district (LAUSD) to help foster the CyberPatriot competition with the goal of increasing student interest in STEM disciplines, especially cybersecurity.

### **INCREASING INTEREST IN STEM DISCIPLINES**

It is well documented that to be successful, students must develop an interest in STEM disciplines before entering a higher education program (UMass Dohahue Institute, 2011). This follows since students must be academically prepared for admission to these programs and such preparation normally requires several years of study in math and science.

To reach talented high school students and encourage their successful pursuit in the second STEM area of technology, Cal Poly Pomona began a partnership with the Los Angeles Unified School District in 2011 to assist with its Beyond the Bell (BTB) program. LAUSD is the second largest public elementary and secondary school district in the nation with 687,534 students and 1,496 schools (National Center for Education Statistics, 2010). As of August 2012, LAUSD had a graduation rate of 62 percent, with a dropout rate of 21 percent. This compares with a statewide graduation rate of 76 percent and a dropout rate of 14 percent.

BTB is an extracurricular program designed to “inspire learning and achievement beyond the regular school day” (LAUSD, 2009). The program connection with LAUSD was made through the University’s Center for Information Assurance with an initial group of students from Franklin High School. The Center hosted both Franklin High students and their faculty coaches on a Saturday event that allowed many students to visit a university campus for the first time.

Of the 180 high school teams that entered the 2012 CyberPatriot IV’s open service division, only twelve were invited to the finals in Washington, DC. Of these finalists, two of the teams,

Franklin High School from Eagle Rock and Reseda High School from Reseda, both represented the Los Angeles Unified School District (LAUSD, 2011).

For purposes of this study, success is not winning the national competition but rather finding an approach that addresses the shortage of skilled cybersecurity experts in the workforce. Early signs indicate a promising start.

### CENTER FOR INFORMATION ASSURANCE

The Cal Poly Pomona Center for Information Assurance was established in 2004 with a strategic mission that combines the College of Business Administration emphasis on strategic use of information technology, the Computer Information Systems learn-by-doing approach to using computers, and the Master of Science in Business Administration emphasis on information systems audit to further the study of Information Assurance and Forensics. The Center supports curriculum, corporate training, high school outreach, camps and competitions that provide hands-on learning in cyber security. Since 2008 the Center has supported the Western Regional Collegiate Cyber Defense Competition at Cal Poly Pomona. In 2011 the Center began a partnership with the LAUSD’s Beyond the Bell program in CyberPatriot.

### RESEARCH METHOD AND RESULTS

Survey data and interviews were used to determine the reasons for, and outcomes from, Cal Poly Pomona’s involvement with the LAUSD CyberPatriot program. Survey data were collected from 146 students competing on LAUSD teams in CyberPatriot. Results are shown below.

#### Survey Data

Surveys were conducted for the 146 participants in the CyberPatriot group and compared with available demographic data for the district as a whole. As shown in Table 1, participants were divided into five categories based on grade level. Participation rates generally increased by grade level with the one exception being a slight drop in the rate for 11<sup>th</sup> grade students. The drop in the number of 11<sup>th</sup> grade students could be attributed to the heavy demands of Advanced Placement classes and taking college entrance examinations. The highest rate was among 12<sup>th</sup> grade students comprising 36% of the group.

6-8th	9th	10th	11th	12th	Total
1	16	43	33	53	146
1%	11%	29%	23%	36%	100%

**Table 1: Participation by Grade Level.**

To assess interest in the STEM category of technology, participants were asked to rate their interest in computing. Three options were provided: yes, no, and not sure with results shown in Table 2. As can be expected for a cyber technology based competition, 68% of the participants

answered Yes to being interested in the computer field but a surprisingly large number, 32%, indicated either No or Not sure. The lack of computer courses could be a reason for those students that answered Not Sure.

Yes	No	Not Sure	Total
100	3	43	146
68%	2%	30%	100%

**Table 2: Interested in Computer Field.**

Gender of participants was 73.3% male and 26.7% female as shown in Table 3. When compared with the district, males had a significantly larger representation at 73.3% versus 51.5% for the population, while females appear underrepresented at 26.7% versus 48.5% for the population. However, the number for females does compare favorably with respect to the rate of national participation by women undergraduate students in computing. Recent estimates have placed enrollments by women at just one in seven or about 15% of the undergraduate computing population in the United States (Misa, 2010). Informally, some female participants mentioned that they joined a team because a friend was on already on a team and didn't want to be the only female.

Category	Male	Female	Total
CyberPatriot	73.3%	26.7%	100%
LAUSD	51.5%	48.5%	100%

**Table 3: Gender.**

Ethnicity results were obtained by asking students to self-identify themselves as one of five ethnic categories: African American, Hispanic, Caucasian, Asian, and Other. Results are provided for both the CyberPatriot students and then compared with the LAUSD. Hispanics comprised the largest ethnic group at 61.7% of the student competitors, followed by Asians at 20.1%, Caucasians at 7.8%, and African Americans tied with Other at 5.2%. When compared with district, students identifying themselves as Asians and Other had significantly larger representations than the remaining categories. Results are shown in Table 4.

Category	African Amer.	Hispanic	Caucasian	Asian	Other	Total
CyberPatriot	5.2%	61.7%	7.8%	20.1%	5.2%	100.0%
LAUSD	10.2%	73.4%	9.5%	5.9%	0.9%	99.9%*

\* difference due to rounding

**Table 4: Ethnicity.**

**Interviews**

To assess the competition and the university-high school partnership, eight interview questions were developed covering three areas of interest: (1) awareness/motivation for participating in the competition, (2) evaluation of the current state of the competition, and (3) needs for future competitions (see Table 5). One question in each area was designed to assess the university/high school partnership itself. Each participant was given the same set of questions.

Area	Cyber Patriot	University Partner
<b>Awareness/motivation:</b> 1. How did you hear about CyberPatriot? 2. Why did you become involved with CyberPatriot? 3. How did you hear about Cal Poly Pomona’s involvement with LAUSD and CyberPatriot	X  X	  X
<b>Current state of CyberPatriot:</b> 4. What is your overall opinion of Cal Poly Pomona’s involvement with LAUSD and CyberPatriot? 5. How have you benefited from being involved with CyberPatriot? 6. What are some of the problems you have seen with CyberPatriot?	 X X	 X
<b>Future needs:</b> 7. How would you like to see CyberPatriot improve in the future? 8. How would you like to see Cal Poly Pomona involved with LAUSD CyberPatriot in the future?	X	 X

**Table 5: Interview Questions.**

Since the CyberPatriot competition under study represents a joint effort between the high school faculty, LAUSD administration, LAUSD student competitors, and industry representatives for LAUSD, the researchers believed it was important to capture opinions representing each of these constituencies. Accordingly, interviews were conducted with Diane Miller—Director, Operations Cybersecurity Group, Northrop Grumman; Bruce Gurnick – CyberPatriot Coach for Reseda High School; Harry Talbot – Administrative Coordinator for LAUSD’s Beyond The Bell program; and Rafael Munoz – a student competitor.

<b>Question 1: How did you hear about CyberPatriot?</b>			
Diane Miller	Bruce Gurnick	Harry Talbot	Rafael Munoz
In 2009, the Air Force Association was seeking a sponsor to enable nationwide expansion of the program. They contacted our outreach/education person about corporate sponsorship. I first heard of the program late that	The CyberPatriot program was promoted to me by both our JROTC teacher and our Beyond the Bell partner ARC, more specifically Rosemary Galan, our ARC site coordinator.	I sent an e-mail to my Air Force friends and one sent back that the program was going to be open to all schools starting in 2011 - so we pressed ahead and we got involved.	I heard about CyberPatriot when I was in the 12th grade (which was around October 2010). A student, Horacio, reached out to contact me because I was one of the more advanced students in the

<p>year when it was presented to our Corporate Cyber-security Executive Committee for consideration.</p>			<p>class and the teacher felt I was better suited to participate in a computer competition. From there, I attended the competition and made it to the Semi-Final Round.</p>
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<p><b>Question 2: Why did you become involved with CyberPatriot?</b></p>			
<p><b>Diane Miller</b></p>	<p><b>Bruce Gurnick</b></p>	<p><b>Harry Talbot</b></p>	<p><b>Rafael Munoz</b></p>
<p>I was already a director in our company's Cybersecurity Group and was offered the opportunity to lead our Sponsorship Agreement with Air Force Association. In addition to the grant awarded by Northrop Grumman to AFA, we are committed to provide subject matter expertise and assist in success of the program using our internal resources.</p>	<p>As you may recall the two people mentioned above teamed up and took turns twisting my arms until I said yes. At the time, I did not think I had the time to devote to coaching a team. I WILL NOT need my arms twisted to convince me to be involved next year.</p>	<p>We were looking for a STEM program that involved a competition and the Air Force Association had opened this one up to all schools.</p>	<p>I became involved with CyberPatriot because at the time, I did not know what was going to be my future college area of study. Since I liked computers, and the idea of securing a computer to prevent hackers from coming in seemed to come from a science fiction movie, I decided to give the program a shot.</p>

<p><b>Question 3: How did you hear about Cal Poly Pomona’s involvement with LAUSD and CyberPatriot?</b></p>			
<p><b>Diane Miller</b></p>	<p><b>Bruce Gurnick</b></p>	<p><b>Harry Talbot</b></p>	<p><b>Rafael Munoz</b></p>
<p>When I participated in the "CyberDayLA" event hosted by LAUSD Beyond the Bell, I was introduced to the Cal Poly Pomona POC, Dan Manson. This was the first time I was aware of Cal Poly's contribution to the program.</p>	<p>Through Beyond the Bell and the partnership we had with Cal Poly Pomona, frequent trips on competition days.</p>	<p>Cal Poly had reached out to Locke HS and we built on that contact.</p>	<p>I didn't hear any announcement but, when I returned to CyberPatriot this year as a tutor, Beyond The Bell told our students that Cal Poly Pomona was more than willingly happy to provide us a room to practice and compete in.</p>

<b>Question 4: What is your overall opinion of Cal Poly Pomona's involvement with LAUSD and CyberPatriot?</b>			
<b>Diane Miller</b>	<b>Bruce Gurnick</b>	<b>Harry Talbot</b>	<b>Rafael Munoz</b>
<p>I'm very excited about how Cal Poly Pomona has reached out to LAUSD and CyberPatriot - I use it as an exemplar when speaking at universities and colleges. Cal Poly has opened their laboratories for use by students during the competition, giving them access to basic internet connectivity unavailable at their school. They have also crafted competition images for the students to practice on. Cal Poly has provided an opportunity for the students to experience the college environment and learn from college students. They recently invited top CyberPatriot competitors from LAUSD to participate in a US Cyber Challenge Camp. They have truly opened the doors for many under-represented students.</p>	<p>Cal Poly Pomona created a perfect site for the competitions except for the distance needed to travel to get there. The expertise of the staff, training provided to students and coaches, as well a motivation, support, and online resources made Cal Poly Pomona an essential part of our first year success in CyberPatriot.</p>	<p>We could not ask for a better connection between a University and a K-12 system, Cal Poly has provided a depth of knowledge combined with student mentors and infrastructure.</p>	<p>I honestly like it better than the way the program was when I first joined. When I was going to competitions, (2010-2011) we were going to different locations to practice in. I remember going to practice at a plane hangar in Torrance and at a café in Whiteman airport and finally competing in the actual rounds at Los Angeles High School. At LA High, the power kept cutting out, and the internet was ridiculously slow. Some students from the CyberPatriot 3 can also tell you that the weather also had a great impact in our study sessions. Mornings were extremely cold and somehow there was rain at almost every location we were in. We never actually had a “fixed” area for practicing or competing, so for [Cal Poly] Pomona to give us a nice location to practice in was a great commodity.</p>



<b>Question 5: How have you benefited from being involved with CyberPatriot?</b>			
<b>Diane Miller</b>	<b>Bruce Gurnick</b>	<b>Harry Talbot</b>	<b>Rafael Munoz</b>
<p>Being the program director for CyberPatriot within Northrop Grumman has been an extremely rewarding experience. As a female executive with a technical background, I realize I represent an unusual demographic. That enables me to discuss academic and career challenges and opportunities with all kinds of students, encouraging them all to pursue opportunities in Science, Technology, Engineering and Mathematics (STEM) and cyber. For Northrop Grumman, being presenting sponsor of CyberPatriot has enabled us to demonstrate our commitment to the STEM disciplines, developing the next generation of cyber professionals, and filling the talent pipeline with qualified individuals. It has given us an excellent source of candidates for internships at both the high school and college levels. It has also benefitted our employees - well over a hundred volunteer as technical advisors and mentors for CyberPatriot teams across the United States, enabling them share their technical expertise within their community.</p>	<p>Training, motivation, online resources, web site, expertise of college students and staff.</p>	<p>We have been connected with academic professionals that understand current theories and practices of the academic and professional community's - through the partnership with CyberWatch West we have been connected with a larger array of cyber security professionals. The willingness of the University to record and create a library of teaching modules has helped to overcome our limited resources.</p>	<p>I have learned a great deal of knowledge in the computer security field from CyberPatriot. You can think of CyberPatriot as a beginner's course in computer defense. If you do all the SAIC lessons and actually practice and compete, you will become familiar with the basics in this field. Have I benefited from the program? Yes, I have and I actually see myself as a penetration tester or a systems administrator in the future.</p>

<b>Question 6: What are some of the problems you have seen with CyberPatriot?</b>			
<b>Diane Miller</b>	<b>Bruce Gurnick</b>	<b>Harry Talbot</b>	<b>Rafael Munoz</b>
<p>The gaming engine has not been as stable throughout the competition periods as is desired. It seems to be severely impacted when large numbers of teams are competing simultaneously. Also, the students need more specific feedback throughout the competition about which actions were effective and which ones did not reduce their network's vulnerability. Otherwise, I believe it's a well-planned and well-executed program.</p>	<p>Vague rules/regulations, ongoing network issues, difficulty in analyzing and understanding the results of the competition i.e. poor feedback on specific hardening and protection success/failures. Results provided do not provide enough educational feedback. The scoring is too much hidden inside a "black box".</p>	<p>The lack of knowledge on the part of our staff - we simply do not have the level of knowledge on the part of our employees to teach at the level required. This has been compounded by the lack of community mentors to support our individual locations.</p>	<p>Not every program is perfect. One recurring issue with cyber patriot is the scoring engine. Every year, CyberNEXS's servers overload and prevent us from scoring. Every student that competes in the competitions can tell you that they are unreliable and can be a real pain. They have tried to find ways of fixing this issue, not by actually fixing the servers but by allowing kids to send in appeals.</p>

<b>Question 7: How would you like to see CyberPatriot improve in the future?</b>			
<b>Diane Miller</b>	<b>Bruce Gurnick</b>	<b>Harry Talbot</b>	<b>Rafael Munoz</b>
<p>I would like to see the gaming engine work properly and scale to the number of teams, as this competition is growing rapidly. I think more facilitated communication among the coaches, perhaps sharing lessons learned, would be effective. I would like to see more coach preparation materials, and perhaps a roadmap through the vast training materials so the coach would know where to begin if they had less time prior to the first competition (if they registered the team later in the cycle). Programmatically, I'd like to see international expansion and I'd like to see some type of implementation at the middle school level. More state-level competitions would also be</p>	<p>Improve network capabilities, scoring, scorebot, and feedback. Clarify and specify the rules regarding time allotments, time frames, for analyzing and hardening competition images.</p>	<p>Continue the growth in training our trainers.</p>	<p>I would like to see it in more schools around the LAUSD and a centralized training structure.</p>

<p>good as Governors are looking for productive youth programs that add value to their state.</p>			
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**Question 8: How would you like to see Cal Poly Pomona involved with LAUSD CyberPatriot in the future?**

Diane Miller	Bruce Gurnick	Harry Talbot	Rafael Munoz
<p>Cybersecurity needs to be a year-round curriculum. I'd like to see Cal Poly Pomona consider hosting CyberPatriots for a summer camp (resident camp with teaching and hands-on competition). One issue I hear repeatedly is the need for a national level cybersecurity curriculum appropriate primarily at the high school level, but with modules/labs/lectures appropriate at the middle school level or younger. Cal Poly Pomona could also host community outreach opportunities - - the CyberPatriot students and Cal Poly Pomona IS students could show the community (individuals, small businesses, clubs/organizations/associations) how to secure their home/business networks through workshop events. Cal Poly Pomona's "Learn by Doing" approach is perfectly suited to cybersecurity competitions - any way they can engage students, excite their interest in STEM and cyber, and encourage their pursuit of STEM/cyber careers is very much appreciated! They have made a tremendous impact on the students of Southern California.</p>	<p>The big drawback to Cal Poly is the distance from schools in the SF Valley and Los Angeles. Even so, I hope to see Cal Poly expand its participation, more online resources, training, and support.</p>	<p>Continue on our current path of instructing and mentoring - possibly the addition of another competition so as teams or as individuals our students can continue to compete.</p>	<p>It is great that [Cal Poly] Pomona is involved with LAUSD CyberPatriot, and for them to retain their alliance in the future would be great.</p>

## ANALYSIS AND DISCUSSION

### **Awareness/Motivation**

Questions 1 through 3 assessed awareness and motivation to participate in CyberPatriot. The results indicate that awareness of the competition at the high school level was gained through informal channels. Two of the three school participants cited word of mouth as the basis for learning of the competition's existence, while one received an e-mail message from a friend. Motivation for participating varied but the goal of winning, in and of itself, was not cited by any of the participants. The idea of CyberPatriot as a STEM program builder was cited by the school administration. All four participants cited Cal Poly Pomona's existing relationship with LAUSD through its Beyond the Bell program as the basis for learning of the University's involvement with CyberPatriot.

### **Current state of CyberPatriot**

Questions 4 through 6 assessed the current state of the CyberPatriot competition. Each of the participants clearly had a positive view of the competition and its benefit to students and future cyber security workers. Each believed that the CyberPatriot program nurtured cyber security skills. Perhaps most importantly, the student competitor expressed a new interest for working in a future cyber security role. With respect to problems with the competition, a range of issues were cited including vague rules, ambiguous scoring, server overloads, power outages, and bad weather. When asked about the role of the University in furthering their plans for CyberPatriot, the participants were unanimous in their positive opinion of the partnership and the role provided by Cal Poly Pomona. All four expressed appreciation for the staff expertise, training, student mentoring, online resources, and infrastructure provided.

### **Future needs for the competition**

Questions 7 and 8 assessed future needs for the competition. Since each participant had a distinctly different role in fostering the event, it was not clear from the outset that there would be agreement about the event's future or what direction it should take. First and foremost, all four participants wished to see the competition grow. Both administrator and student requested better training for the event: more development for staff was requested as well as a centralized training structure for student competitors. The faculty coach requested resolution of the technical problems cited earlier, clarification of competition rules, and better feedback for competitors to improve the educational value of the event. The industry representative also suggested community outreach events where faculty and cyber security students would work directly with interested parties to show them how to secure their home/business networks. All four expressed the desire to see a stronger partnership with the University but perhaps with more online resources to reduce the need for commuting to campus. In addition to the existing competition, the district would like to see an additional university-hosted cyber defense competition for students that would occur during the off-season.

## CONCLUSION

Cal Poly Pomona is in the early stages of its partnership with LAUSD in CyberPatriot. From the standpoint of building a better cyber security workforce, initial feedback appears promising. The partnership itself is being strongly embraced by the high school faculty, administrator, and student representatives interviewed for this study. As the program continues to develop, Cal Poly Pomona will have an opportunity for an ongoing partnership with LAUSD through CyberPatriot and cyber security student skills development. This development can expand beyond competitions to both faculty and curriculum development. We believe this is a partnership model that can be easily replicated by other institutions of higher learning.

Future research should focus on tracking students from their initial involvement in CyberPatriot through college and into their professional careers. Longitudinal research in this area can provide significant contributions to success factors in an area that has individual, industry and national security implications.

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