

## The Role of Extracurricular Activities in Cybersecurity Education

In order to sustain the long-term needs of the cybersecurity workforce, more young people must be recruited to pursue cybersecurity-related careers. Career trajectories are often shaped early, even as early as middle school. It is therefore essential that more interventions and outreach efforts target these earlier age groups. Cybersecurity education is severely lacking at the primary and secondary school levels [1], and does not appear to be improving in any significant and widespread way. Most K-12 schools around the country are over-tasked and under-funded, and there is little room for new programs. While the “CS for All” initiative has gained some traction lately, it has been, and continues to be, a long uphill battle. It is unlikely that cybersecurity will ever be able to evoke the same broad appeal as an academic subject, and cybersecurity will almost certainly remain a rare subject in American primary and secondary schools for the foreseeable future. Therefore, the best way to introduce these young students to cybersecurity topics and careers has to be outside the classroom, with extracurricular educational activities.

Studies have found that extracurricular activities can have a significant impact on students’ educational and career choices, and they can be an effective avenue for stimulating interest in specific career fields. Competition-style activities have been particularly successful at getting more students interested in STEM careers. A study of past participants in the National Ocean Sciences Bowl, for instance, found that 41% of respondents indicated that participation influenced their choice of career, and 39% said that it influenced their choice of college major [2]. Extracurricular competitions can also help launch talented students into highly successful careers. Winners of academic Olympiad competitions were found to significantly outperform their peers in various measures, and both participants and their parents agreed that the Olympiad developed their talent and fostered their future accomplishments [3]. These types of activities can help motivate students to pursue a subject and/or career, and to strive for excellence in that field. The activity can serve as an impetus to get the student started, and to help drive them toward

success when they get bored or frustrated. These activities also foster role-model relationships between professionals, who often serve as mentors and judges, and the students participating. Meaningful interaction with “real” practitioners can have a powerful impact on a young person. This is especially important for students who do not often receive exposure to a wide range of careers, and to students who may have difficulty seeing themselves in a particular career because their race or gender is underrepresented [4].

It is encouraging that competition-style extracurricular activities have been successful in other STEM fields, since competitions are already one of the most popular forms of cybersecurity activities. There are now dozens of cybersecurity competitions, both large and small, for varying skill levels [5]. One of the most popular is the Collegiate Cyber Defense Competition (CCDC), a national cybersecurity tournament for college students, with affiliated regional competitions [6]. CCDC has gained popularity especially for its value in creating hands-on learning experiences for students in cyber and computing related fields. It also has the potential to increase the inflow of new students into the cybersecurity profession, by recruiting, retaining, and identifying students who would be interested and adept in cybersecurity roles [5], [7].

As discussed earlier, however, college is too late for many students, who may have already chosen a different career path. It is important, therefore, to provide opportunities below the college level. The only truly national program of cybersecurity extracurricular activities for middle and high school students is CyberPatriot [5], [8], run by the Air Force Association, CyberPatriot bills itself as “The National Youth Cyber Education Program” [9]. The central element of the CyberPatriot program is the annual cyber defense competition, in its tenth season as of the 2017-2018 school year. Small teams of middle or high school students scour a virtual computer for vulnerabilities, such as viruses, backdoors, and incorrect security settings, then eliminate those vulnerabilities for points. These teams can come from public or private schools, homeschool groups, Junior ROTC programs, Civil Air Patrol units, or other approved youth organizations [8], [10], [11]. A recent study [12] demonstrated that participation in the CyberPatriot program leads to increased interest in cybersecurity as an educational or career prospect. Furthermore, that increased interest was found to persist over time, leading to significantly increased likelihood of actually entering the cybersecurity workforce. The CyberPatriot program is also contributing positively to correct the gender imbalance in the

cybersecurity workforce. Female students consistently make up over 20% of the competition—approximately double the industry average [13]—and despite lower initial interest in cybersecurity careers among female participants, this interest increased by an even greater amount than it did for males.

In addition to CyberPatriot’s national program, there are many excellent extracurricular programs springing up around the country. Many colleges, universities, and other organizations host locally-organized cybersecurity camps for local students and/or teachers. These camps are often supported by GenCyber [14], a joint National Security Agency and National Science Foundation grant program that enables select camps to be offered free to participants. There are also numerous small, independent non-profit groups offering a variety of programs to local youth, based on the passions of their volunteers and the availability of donor funding. Examples of such programs include Cyber Warrior Princess ([www.cyberwarriorprincess.org](http://www.cyberwarriorprincess.org)) in Ohio, GhostWire Academy ([ghostwireacademy.org](http://ghostwireacademy.org)) in Texas, and many others. These programs and others like them give young people opportunities to delve deeper into cybersecurity, opportunities they would not have had through traditional education systems.

Another approach for using extracurricular activities to introduce young people to cybersecurity is to incorporate cybersecurity content into existing youth programs. Civil Air Patrol and multiple Junior ROTC programs have done this very successfully using the CyberPatriot competition. The Girl Scouts of the USA have recently announced their plan to introduce a series of age-appropriate cybersecurity badges to their programs. This is a great example of how other youth programs can add cybersecurity to their offerings as well; in fact, Scouting badges are frequently cited as the prime model for using badging to motivate learning [15], [16]. The Boy Scouts of America has a program for personal online safety education [17], though nothing currently for cybersecurity. A team of professionals and educators is working to change that by designing and proposing a new Cybersecurity merit badge [18]. The great advantage of incorporating content into well-established youth programs is the breadth of the audience. Participants in these youth programs often try different activities just because they are offered by the organization (and maybe to earn a badge), potentially setting them on a path toward a career they would not otherwise have considered.

Extracurricular activities are establishing themselves as the centerpiece of cybersecurity education for American middle and high school students, and this trend is likely to continue. It is

critically important that the cybersecurity community as a whole embrace and support these programs, and they should be considered a central aspect of the overall strategy for K-12 cybersecurity education.

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