Student Research Involvement in a Scholarship for Service Program

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Abstract

Research for students can be an essential addition in the education of future professionals, particularly in rapidly developing areas such as cybersecurity. The future workplaces require professionals that can identify, analyze, act, and document findings as part of their profession. Students who graduate having absorbed these skills are better positioned to be effective in the cybersecurity profession, thus benefiting society overall. In this paper, we discuss one potential opportunity for research experience provided by the CyberCorps®: Scholarships for Service (SFS) program, managed by the National Science Foundation, in collaboration with the U.S. Office of Personnel Management and the Department of Homeland Security. The SFS program provides students with scholarships in support of education in the areas that are relevant to cybersecurity. In return recipients agree to work after graduation for the federal government in a position related to cybersecurity for a period of equal length of the scholarship. SFS programs aim to recruit scholars that have a high probability of graduation; thus, the profile of these students will be high-GPA, mature, self-driven and responsible—qualities that align well with researchers. However, it is not a requirement of the SFS program that students complete any research experiences or research endeavors, i.e., participating in research or publishing scholarly work. Engagement in research during their academic years opens potential future advanced degree avenues for the students after they fulfill their service commitment. The potential to contribute to the state-of-the-art research is attractive to all top scholar students and cybersecurity students are not an exception especially that the domain is advancing so rapidly. Given that the scholarship commitment is documented through the SFS program management office, SFS PIs maintain contact with the scholarship graduates until they complete the required work and can advise the scholars on their intended advanced degrees if the scholars intend to pursue this opportunity. Having contributed in the past to creative scholarship will make these potential students an ideal recruiting pool for the SFS PIs to enlarge their research groups. In this paper we examine through observations two SFS sites, and how students, if given the opportunity, will engage in research activities. For those students that are involved in research, we conducted an interview, capturing their profile, the benefits they are observing in their professional development, and their intended careers after completing their service commitment. We report on these results and discuss ways to encourage further engagement with SFS scholars for research.

Keywords – CyberCorps, Cybersecurity, Scholarships for Service, Student Research

I. Introduction

It has been shown that integrating research opportunities into students' academic journeys is a pivotal strategy for developing the next generation of experts [1]. This is particularly true in dynamic and rapidly evolving fields, e.g., cybersecurity. Within the cybersecurity domain the

demand for skilled professionals continues to escalate, mainly in response to the increasing digital threats and the complexity of safeguarding information systems. Skilled cybersecurity professionals must have the ability to identify, analyze, act upon, and meticulously document findings to effectively combat cybersecurity threats and attacks. Thus, there is a dire need to train and develop cybersecurity professionals to meet the escalating needs of the American society.

The CyberCorps®: Scholarships for Service (SFS) program has been established to increase the number of skilled cybersecurity professionals to meet the cybersecurity mission needs of Federal, State, local, and tribal governments. The SFS program offers scholarships to students pursuing education in cybersecurity-relevant areas. In exchange, scholar recipients commit to serving in government positions related to cybersecurity for a period equivalent to the scholarship duration.

The SFS program effectively attracts high-caliber students—characterized by high GPAs, maturity, self-drive, and responsibility. However, in its current format, it does not mandate participation in research activities or the pursuit of scholarly work. There is a great potential opportunity to enhance the professional and academic trajectories of SFS scholars through the introduction of research experiences. Engaging in research during their studies can not only enrich their educational experience but also open doors to advanced degree programs and cutting-edge contributions to the field of cybersecurity, whilst producing better trained cybersecurity professionals. Given the swift advancements in cybersecurity, fostering a research-oriented mindset among scholars is both timely and essential.

II. Motivation

The motivation for this work stems from the realization that integrating research experiences into the SFS program can substantially benefit both the students and the broader cybersecurity community. SFS scholars, due to their proven academic excellence and dedication, are well-positioned to excel in research endeavors. By facilitating their involvement in research, the SFS program can further enhance the development of scholar's skill sets, prepare them for leadership roles, and contribute to the advancement of cybersecurity knowledge and practices. Furthermore, because scholars must ultimately join the government to fulfill their obligation, incorporating research within the SFS framework will naturally lead to the government adopting more innovative solutions, thereby strengthening national security.

This work explores the potential for integrating research activities into the SFS program by examining two SFS sites through observational studies. The aim of this work is to understand how SFS scholars engage with research when given the opportunity and to identify the benefits such engagement offers to their professional development. The approach used in this work involved interviewing scholars to capture detailed profiles, investigate the perceived advantages of the research involvement and identify planned career intentions after completing their service obligations. The findings of this work can inform strategies to encourage greater research participation among SFS scholars for current SFS sites.

III. Background

The CyberCorps®: SFS program is an initiative aimed at addressing the critical shortage of skilled cybersecurity professionals in the United States [2]. Established under the National Science Foundation (NSF), the SFS program is administered in collaboration with the U.S. Office of Personnel Management (OPM) and the Department of Homeland Security (DHS). The SFS program provides comprehensive scholarships to students pursuing degrees in cybersecurity-relevant disciplines. These scholarships typically cover tuition, fees, a professional development allowance, and provide a living stipend, alleviating the financial burdens that often deter talented individuals from entering the field. In return for this support, scholarship recipients commit to working in a federal government position related to cybersecurity for a period equivalent to the length of their scholarship. Furthermore, as part of the training and development, scholars are required to participate in one meaningful summer internship that is related to cybersecurity.

SFS applicants must satisfy a set of specific criteria to be eligible. First, as scholars must fulfill their obligation within the United States government, applicants must be either a citizen or a lawful permanent resident of the United States. Secondly, applicants must demonstrate a strong commitment to pursuing a career in cybersecurity, which can be evidenced through relevant academic pursuits, professional experiences, or articulated as career goals. Furthermore, applicants must be enrolled as full-time students in an academic program focused on cybersecurity at an NSF-awardee institution. This includes requiring applicants to be in a sophomore standing within an associate's degree program, junior or senior standing in a bachelor's degree program, or currently enrolled in a master's degree program, or participating in a research-based doctoral program.

Academic institutions are funded through NSF to manage the SFS program [3]. Institutions must define the specific criteria used to select scholars, the approach used to recruit and award scholarships, how to mentor and monitor scholars, and to ensure they meet all the obligations required. SFS NSF awards typically last five years and there is a renewal mechanism in place to fund those programs that can show continuous success.

IV. Approach

Given that participation in research activities is not a mandatory component of the SFS program, a targeted approach was employed to identify and engage scholars who had voluntarily undertaken research experiences during their SFS scholarship period. Initially, scholars from two selected SFS sites, i.e., the University of Texas at El Paso [4], and Embry-Riddle Aeronautical University [5], were reviewed to identify individuals involved in research projects. The principal investigators of the SFS programs facilitated the identification of scholar research activities and achievements. Once identified, these scholars were approached with the goal of conducting an interview. The interview aimed to establish a profile of academic maturity, i.e., what degree and expected graduation, and to investigate the skills they developed, and the perceived benefits to their professional and academic growth by participating in research. Additionally, questions aimed at identifying what the long-term goals after are completing their SFS service obligation.

From both institutions, 25 scholars were analyzed for research participation resulting in the identification of seven scholars that actively participate in research. Of those seven scholars, only six scholars were available for interviews.

V. Results

The following table captures at a glance the profile, perceived benefit and the long-term goal of the scholars interviewed.

Table 1. Summary of Scholar Interview

ID	Degree/Graduation	Perceived Benefit Summary	Long-Term Goal
Scholar A	MS/May 2025	Increased expertise	Undecided
Scholar B	MS/May 2026	Increased expertise	Government
Scholar C	BS/May 2026	Increased expertise; network connections	Industry
Scholar D	BS/ May 2027	Increased expertise	National Lab
Scholar E	MS/May 2026	Increased expertise; network connections	Academia
Scholar F	MS/ May 2026	Increased expertise	Further Education

As can be seen from Table 1, there is a good representation of undergraduates and graduate scholars, with a wide range of long-term goals. But most interestingly, every single scholar expressed the same perceived benefit, an increase in expertise by participating in research. The following sections analyze the common themes among the answers.

Growth in Cybersecurity Skills

Analyzing the responses provided by the scholars paint a compelling testament to the benefits of engaging in research activities within the SFS program. A recurring theme across the responses is the enhancement of critical and technical skills. Scholars consistently highlight the development of problem-solving abilities, critical thinking, and technical competencies essential for their cybersecurity careers (i.e., Scholar A, Scholar B, Scholar E, and Scholar F). For instance, Scholar A emphasizes the acquisition of problem-solving and communication skills, "...aside from technical skills I am gaining important skills such as problem solving, strengthening my communication and collaborative that are essential for a position in my field…", while Scholar E underscores the strengthening of critical thinking and technical communication, "It strengthens my critical thinking skills and helps me learn how to communicate technical matters." And Scholar F says "…It allows me to gain a more in-depth knowledge of topics in my chosen degree field of cybersecurity." These skills are pivotal in addressing complex cybersecurity challenges.

Hands-On Experience

Another significant theme identified is the value of hands-on experience and learning from experts. Scholars B and D mention the importance of gaining practical, hands-on experience and benefiting

from the expertise of mentors and peers. Scholar B notes that research fosters innovative thinking necessary for tackling real-world challenges, "…research hones my problem-solving skills and fosters innovative thinking…", whereas Scholar D highlights the exposure to the latest trends and continuous learning opportunities that extend beyond the formal curriculum, "Because you are surrounded by great minds and people who always wish to learn, you learn about the latest "trends" in your career or in your area. Thus, helping you stay up to date with material that might not even be covered in your classes…". This practical engagement not only deepens their understanding of cybersecurity but also keeps them abreast of emerging technologies and methodologies, thereby enhancing their employability and readiness to contribute to the field.

Professional Networking

Networking and professional connections emerge as additional critical benefits. Scholars C and E discuss the importance of building and refining professional networks through interactions with diverse individuals and participation in conferences and workshops. Scholar C points out the advantage of making connections that can aid in career development, "…I have and will make many connections with various and distinct people that can also help me build my profession career.", while Scholar E highlights the opportunity to network beyond the university environment, "…most importantly, it gives me the chance to network, with not only those at my university, but others at conferences and workshops." These connections are invaluable for career advancement, providing access to mentorship, collaborative opportunities, and potential job placements within the federal cybersecurity landscape.

Career Growth

The responses indicate that research involvement contributes to personal and professional growth. Scholar D describes being surrounded by goal-driven individuals in a stimulating environment, which fosters continuous personal development and professional ambition, "…I get to be surrounded by an environment of people who wish to constantly learn and pursue their goals. They are very goal-driven, and just by being there you know you are in a space where you will be constantly learning and working on projects, papers, competitions, or some tasks that will undoubtedly help you grow both as a person and in your career…". This environment not only supports academic and career growth but also instills a sense of purpose and motivation among scholars, encouraging them to contribute innovative ideas to the cybersecurity domain.

The enhancement of career prospects and resume strength is a notable outcome of research participation. Scholars E and D explicitly mention how research experience adds valuable skills to their résumés and helps them stand out to recruiters, Scholar E said "…I believe that by participating in research, I'm adding a valuable skill to my resume that will help in my future career….". This advantage is crucial in a competitive job market, where differentiated skills and experiences can significantly influence hiring decisions.

Interestingly, Scholar E directly attributes his long-term career goal of being in academia to having had a research experience, "…I had no interest in academia before joining research…".

VI. Discussion

Overall, the analysis of SFS scholar responses highlights the profound impact that research engagement can have on SFS scholars. Research experience can provide opportunities to develop essential skills, provide hands-on experience, foster professional networks, and enhance career prospects. Research participation can significantly contribute to a more complete development of cybersecurity professionals, extending past the established curriculum [6]. The result of this work provides an important argument for integrating more research opportunities within the SFS program, highlighting the potential to further elevate the program's effectiveness in preparing scholars for successful careers in cybersecurity.

Furthermore, it is important to recognize that SFS scholars benefit from financial stability, which affords them the flexibility to engage in research activities without the burden of external employment. Unlike their peers who may need to undertake part-time or full-time jobs to support themselves financially, SFS scholars can dedicate more time to research pursuits. This financial freedom enables them to participate in research projects that align with their desires, in the case of SFS scholars that would be cybersecurity growth. Whereas other students might pick up any research project that is offered to them even if it does not align with their primary career desires.

VI. Research Engagement Recommendations

In this section, recommendations are described to engage SFS scholars in research at other institutions.

Mentoring

Effective mentorship is crucial for encouraging a research-oriented culture. Pairing SFS scholars with experienced faculty mentors who are actively involved in research can provide the guidance and support necessary for successful research participation. Mentors can assist scholars in identifying suitable research projects and research faculty. Additionally, establishing a mentorship network that includes industry professionals can offer diverse perspectives and enhance the practical relevance of research activities. Mentoring is part of successful SFS programs; thus, it becomes a natural place to encourage research participation and advertise the benefits of doing so.

Advertise Benefits

It is important to advertise the benefits of participating in research. This includes organizing opportunities to showcase firsthand accounts from successful SFS scholar researchers, providing both opportunities for other scholars to learn more from their peers and providing rewarding acknowledgement for participating in research. Developing targeted marketing materials such as brochures, newsletters, and digital content that highlight testimonials and success stories can

further illustrate the tangible benefits of research participation. A hall of fame type of media can be built into SFS websites where the program showcases successful SFS researchers.

Leverage Financial Support with Research Faculty

SFS principal investigators can engage with faculty by explaining the funding mechanisms available through the SFS program and encouraging them to involve SFS scholars in their research projects. In response, research-focused faculty can promote and highlight their ongoing research studies, aiming to attract these fully funded scholars to participate actively in their research initiatives.

VII. Future Work

Building upon the findings of this work, future research should aim to expand the scope by including a larger and more diverse sample of SFS institutions. This expansion would provide a more comprehensive understanding of how different institutional environments influence SFS scholars' engagement in research activities. Additionally, longitudinal studies could be conducted to assess the long-term impacts of research participation on scholars' career trajectories and professional development. Specifically, it would be valuable to investigate whether involvement in research experiences correlates with an increased interest in pursuing research-oriented positions, e.g., roles in academia, research laboratories, or advanced cybersecurity initiatives within government agencies.

Further research could also explore the qualitative aspects of scholars' experiences by conducting in-depth case studies and interviews that delve into the motivations, challenges, and personal growth associated with research participation. Understanding these factors can inform the development of more tailored and effective engagement strategies. Moreover, comparative studies between SFS scholars who engage in research and those who do not could shed light on the differential benefits and potential gaps that need to be addressed within the program.

VIII. Conclusion

Integrating research opportunities into the SFS program presents a potentially transformative enhancement that can significantly benefit both the scholars and the broader cybersecurity landscape. This work has demonstrated that voluntary engagement in research activities fosters the scholars’ perceived development of critical technical and soft skills, e.g., problem-solving and critical thinking, which are essential for effective cybersecurity professionals. Moreover, scholars report that research participation not only bolsters career prospects by making scholars more competitive in the job market but also facilitates valuable networking opportunities and contributes to personal and intellectual growth. The unique financial stability provided by the SFS program allows scholars the freedom to pursue research without the constraints that typically limit their peers

To effectively engage scholars in research, a comprehensive approach is essential. The work presented here describes that establishing mentorship that can support research involvement. It also encourages communication and involvement from principal investigators to encourage faculty recruitment of SFS scholars. Additionally, advertising the benefits of research is paramount in motivating scholars to actively participate in research activities.

Enhancing the SFS program with structured research opportunities and effective engagement strategies not only enriches the educational and professional experiences of SFS scholars but also can further contributes to the advancement of cybersecurity knowledge. SFS program can better prepare its scholars to meet the evolving demands of the cybersecurity workforce through incorporation of research experiences which ultimately can strengthen national security and promote innovation within the field.

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