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Summer Engagement in Cyber Undergraduate Research Experiences (SECURE)

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Joseph Zambreno has been with the Department of Electrical and Computer Engineering at Iowa State University since 2006, where he is currently a Professor. Prior to joining ISU, he was at Northwestern University in Evanston, Ill., where he graduated with his Ph.D. degree in electrical and computer engineering in 2006, his M.S. degree in electrical and computer engineering in 2002, and his B.S. degree summa cum laude in computer engineering in 2001. While at Northwestern University, Zambreno was a recipient of a National Science Foundation Graduate Research Fellowship, a Northwestern University Graduate School Fellowship, a Walter P. Murphy Fellowship, and the EECS department Best Dissertation Award for his Ph.D. dissertation titled ”Compiler and Architectural Approaches to Software Protection and Security.”

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Abstract

Background: This virtual initiative, called Summer Engagement in Cyber Undergraduate Research Experiences (SECURE), was established as a response to support students who may have lost summer internships and/or have financial hardships due to COVID-19. Several students in the program were NSF S-STEM scholars, a mix of computer engineering, cyber security engineering, electrical engineering and software engineering students.

Purpose/Hypothesis: The main question addressed by this initiative was whether we could build a virtual undergraduate research experience that enabled students to apply their studies and knowledge similarly as they would in a traditional summer internship. Goals for the experience included providing small-group mentoring as well as broader opportunities for students to learn about design and research skills and to collaborate across projects

Design/Method: Sixteen paid students were assigned to one of ten projects. Several students were classified as sophomores, and others were more advanced. Projects were proposed by faculty mentors with an emphasis on the development of educational experiences using research and/or design approaches. Several projects revolved around cyber security. We introduced students to the research process, while adapting to the limitations of a virtual program. While our main goal was to support students and provide summer work, we also made progress on projects that were established before the program.

Results: The SECURE program operated from May 18 through July 31, 2020. The program was funded using funds remaining in an NSF grant with the approval of the program manager. It was successfully implemented through the concerted efforts of faculty, staff and graduate students to rapidly set up program operations. The goals for the program were met, and the feedback from the students and mentors were very positive.

Conclusions: We demonstrated it is possible to rapidly build a virtual internship program to meet student needs, and we are working to obtain funding to continue the project next summer. The future goal will be to offer a hybrid model where students can be virtual or a combination of virtual and on-campus.

Keywords: Cyber security, educational projects, faculty mentors, virtual research experience

Project Overview

The Summer Engagement in Cyber Undergraduate Research Experiences (SECURE) program was a virtual undergraduate research program offered during summer 2020 for electrical, computer, cyber security and software engineering students who may have lost internship opportunities due to COVID-19. The objectives of the program were to support students financially, professionally and socially and engage them in research-oriented training experiences. Projects covered a wide range of topics, including topics that students may have been unfamiliar with. With ongoing support from peers and mentors, students made substantial

progress or completed projects. In culmination of the program, students created a poster to highlight their progress and showcase their final work. This project was conceived and stood up in about a month.

As background, three of the authors direct the Iowa State University Electrical, Computer, and Software Engineers as Leaders (ECSEL) program, funded by a grant from NSF S-STEM, which provides financial support to help low-income, academically talented students obtain STEM degrees and enter the workforce or graduate study [1], [2]. ECSEL is a partnership between the Department of Electrical and Computer Engineering at Iowa State, the Program for Women in Science and Engineering, Des Moines Area Community College, and Kirkwood Community College. Over five years, grants at all three institutions will fund hundreds of scholarship awards for students majoring or preparing to transfer in electrical engineering, computer engineering, software engineering, and cyber security engineering as well as implement a student experience model to help participants thrive and succeed in their degree programs.

The initial discussions to create the SECURE program came from feedback we were getting from the ECSEL scholars in early April as they were receiving notices about their internships being canceled. The authors of the paper started to brainstorm about ways we could help the students and provide a summer experience that could replace the internships. The first issue was to identify funding for the students of about $5000 for 10 weeks, assuming students would work about 30 hours a week. While funding was not available from the NSF S-STEM program, we reached out to another NSF program to see if we could repurpose the leftover faculty salary portion of a large scholarship grant that was ending on July 31, 2020 [3]. The NSF program manager agreed but wanted the projects to have an educational focus, or part of their final product to be used in the classroom. We then set out to recruit faculty mentors and share the opportunity with students in the ECSEL program and others interested in an internship. We ended up with 16 students, 11 faculty mentors, and 10 projects.

The SECURE program is an example of virtual undergraduate research experiences that emerged around the country in response to the pandemic. In data reported by Parry, most NSF REU sites in chemistry and engineering were canceled, with only about one-sixth transitioning to virtual [4]. In the geoscience community, there was an extensive coordinated effort to quickly find alternatives, with several models of adaptation being used: 1) fully virtual internships, 2) virtual professional development-focused programs, 3) virtual field camps and summer courses, and 4) pop-up remote research opportunities [5]. Despite the difficult circumstances, the virtual models identified key elements of evidence-based practices of successful undergraduate research experiences [6], [7]. Of the models given in [5], the SECURE program is a blend of 1) and 4), with faculty mentors supervising the virtual research experiences and program leaders hosting weekly meetings and fostering cohort building.

The remainder of the paper will describe the project management, common group meetings, mentor-student interactions and student feedback.

SECURE Program Management and Funding Model

We did not have a formal management structure, in part because the authors have worked together for years on various projects. This was very helpful given that the program planning was also done virtually, mostly through emails. We each took on roles as needed to stand the program up including working through the funding, recruiting faculty and students, matching students with mentors, and developing the weekly group meetings. As we were brainstorming about the program, we identified several goals.

- First we wanted to reduce any burden on the faculty mentors, this included centralizing student time reporting, managing overall accountability, and providing a common project reporting format. This allowed the faculty mentors to focus on working with their student(s).
- Another goal was to provide a common experience for the students and build a sense of community. The common experience included training, professional development and special topics, such as innovation, project management, and science communication. To help facilitate this we used Slack and weekly Zoom meetings. The activities and interactions are described in the next section.
- The third goal was to provide an experience that was meaningful for the students and provide them an opportunity to learn new skills and to contribute to the mentor's project.

We created a Slack workspace for the SECURE program and individual channels for each project. This way, students could communicate easily with mentors and other students. Additionally, students wrote a brief weekly report, highlighting their work from the past week in a couple of paragraphs, and posted this in Slack for everyone to read. All students joined a virtual Zoom meeting each week to discuss professional development topics, including communication, teamwork, design skills, research skills, ethics, innovation and creativity. Individual project groups also met in virtual meetings as needed to update one another and mentors. These meetings fostered open discussion of the project and development of new goals.

As mentioned above we had targeted providing $5,000 to each student for a 10-week internship. The 10-week window was set because the NSF funding ended on July 31. When we conceived of the project we intended to give stipends to participants and not deal with hourly pay and time reporting. This became complicated under Iowa State's procedures, and we quickly pivoted to hourly pay and set the hourly rate such that they would get $5,000 for working 30 hours a week for 10 weeks. We were able to start the project on May 15, just a month after the initial idea was proposed.

We had also not considered the time it would take to get each student on payroll and to help them understand how to enter time into the electronic timekeeping system. During the week leading up to the start of the project we worked with the students to help them understand how to enter time and that they were to keep their total weekly hours under 30 hours. We were fortunate to have support from our college's research institute to help process the student payroll.

After finalizing the number of students in the program, there was enough funding available to allow the students through their faculty mentors to purchase equipment (FPGA boards, robots, etc.) to support their projects. As we reached the end of the program, there were sufficient funds remaining in the account to provide an additional $600 for each student in their last payroll

period as a one-time payment. Moving forward we plan to resolve the stipend versus hourly issue so we can just pay a stipend.

Student Projects

We knew we had between 15 and 20 students that were interested in the SECURE program, so our first step was to identify faculty mentors and projects. We started with an email to the faculty that were part of the S-STEM ECSEL program and also a few faculty members that teach cyber security. The faculty were asked for a paragraph on a project that had an educational focus in computer, software, electrical, or cyber security engineering. We also described the overall program, their time commitment and what support we would provide. We received close to 20 projects from the faculty. Most of the projects were asking for a team of 2 students. Once we got the project list we surveyed the students for their top 3 choices and then matched the students with a project. The process ended up with 10 projects and 16 total students.

As mentioned earlier the authors wanted to provide some consistency in the student accountability and reporting. The students were required to provide a paragraph each week in Slack that addressed what they accomplished during the week and any issues that they were having. The students were also asked to create a poster and a video describing their project that was due at the end of the program. We also encouraged them to submit the poster to an ISU undergraduate research symposium that was held virtually at the beginning of August. Seven of the 10 projects submitted a poster and video to the ISU undergraduate research symposium. To help them with the poster we provided a template and spent time during one of the weekly meetings discussing posters, other methods of dissemination of research results, and the importance of being able to communicate technical concepts to a general audience.

The projects are listed below and more detailed descriptions of the projects along with the posters and short videos can be found at http://www.iac.iastate.edu/secure.

- Project 1: Lab Environment to Support the Cyber Security Essentials Project - two students, one mentor
- Project 2: IoT Security Project - two students, two mentors
- Project 3: Remodeling Computer Engineering 185 for Safe and Virtual Learning - two students, one mentor
- Project 4: Freshman Engineering Hybrid Design Course - two students, one mentor
- Project 5: Mapping Machine Learning to Algorithms to Edge Nodes - one student, two mentors
- Project 6: A Comparison of Platform Configurations for Robotics Development - two students, two mentors
- Project 7: FPGA-based Graphics Processor Lab Environment - one student, one mentor
- Project 8: Creating an Innovation Learning Experience with Design Thinking and Innovation Heuristics - one student, one mentor
- Project 9: Development of High School Cyber Defense Competition Curriculum - two students, one mentor
- Project 10: Draftback for GITLAB - one student, one mentor

Group Interactions

We knew during this time of isolation and trying to hold a virtual internship we needed to create a sense of community and provide an opportunity for the students to interact with each other. We held weekly Zoom sessions where all 16 interns attended, and we also invited faculty mentors to the sessions. We also wanted to provide sessions that would help them not only with their project but help them as they enter their careers. In an ideal world we would have planned the sessions in advance and would have provided the students with a schedule and additional resources. Going into the summer we had a rough idea for a few of the Zoom sessions. As the summer progressed we adapted to meet the needs of the students and the projects. Below is a list of several key sessions we held during the summer along with a brief description of each session.

- Introductions: The first session was designed to allow students a chance to get to know each other and the program leaders. This was made easier since all but three of the students were part of the S-STEM ECSEL program. Given the quick start to the program, the introductory session was held about a week after the projects started, which was not ideal. During the session we also talked about expectations and answered questions. Before this session, the students were asked to tell something about themselves using the Slack workspace. They had also started to work with their faculty mentors. This session provided our first insights into the need the students had to interact with others. The students had been out of the classroom for over two months.

- Questioning skills: This session focused on how to ask good questions. Since we provided very little information about the projects the students needed to ask questions of their mentors. These skills would also help the students in other classes and in their jobs. The value of questioning skills in critical thinking, design and innovation was also presented. This session was designed to be interactive and we used Zoom breakout rooms to help create discussions. Resources from the Right Question Institute were used [8].

  Topics from "The Innovator's DNA" were discussed [9]. We introduced and supported innovation from the perspective of recent studies about the ways that engineering students experience innovation [10]-[12]. In particular, recent studies have investigated project and environment characteristics that support student innovation, for example, project contexts that include authenticity, autonomy, support, interest and novelty. Studies have also investigated student behaviors commonly linked to innovation, including questioning, observing, (idea) networking, and experimenting [13] [14]. These are key skills that we wanted to emphasize in the program and projects.

  Several faculty mentors also participated in the 2020 ASEE Virtual Conference, which included a performance by Kai Kight on innovation, and this was shared with the students [15].

- Presenting your work: Since each project needed to have an educational focus and/or produce something that can be used in the classroom we wanted to talk about presenting materials to a wide audience. We walked through a few examples and had some of the mentors talk about their experiences presenting to a non-technical audience.

- Writing an abstract and creating a poster: This session was added when we decided the students would produce a poster and an abstract as part of the poster submission. We provided them with examples of abstracts and talked about the purpose of an abstract. We also discussed elements of and goals for a poster. Several resources about research and poster presentations and science communication were provided to guide students and their mentors [16]-[20]. We mentioned that not only would the poster help them in their careers, but it would help us seek funding to continue the program. Interestingly, several of the students were genuinely excited about our desire to continue the program going forward, and they wanted to know how they could help. This was equally exciting for us to see.

- Reflections: In the final session, students talked about their projects and experiences. Most of the session was spent having various informal conversations. We also announced that each student would receive an additional $600, which was the remainder of the NSF funds.

Mentor – Student Interaction

All of the faculty mentors were serving as mentors in the S-STEM ECSEL program and thus were involved with mentor training from that program. Mentoring resources used by faculty and students in ECSEL include principles, practices, worksheets and guides developed by Packard, Montgomery, Engage Engineering, and LSAMP Indiana [21]-[26]. We held an initial meeting with faculty mentors to review SECURE program goals for the virtual research experiences and mentoring relationships.

It was up to each faculty mentor to establish a method of communication between themselves and the students. Some faculty mentors proposed projects that were new and others wanted to add the SECURE students to an ongoing project team. We did provide some guidelines to the faculty mentors and we created a Slack channel for each project. Several groups used that as their primary mode of communication. Every student was asked to provide weekly progress updates that were posted to Slack which not only helped hold the students accountable, but also allowed students to see the progress of the other teams.

We did not formally collect feedback from the mentors therefore we have only the experiences of the authors and informal feedback from other mentors about mentor-student interaction. One key takeaway from our interactions was that the students wanted to not only talk about the technical aspects of their projects but also wanted to have social interactions. Many of the students had left campus in March and had limited interaction with other students and faculty since then. Many of the weekly virtual meetings were more social than technical and they tended to use Slack as the way to communicate technical information. As described above this was also part of the group interaction.

Student Reflections

At the conclusion of the summer program, we asked students to complete an end-of-program reflection. We used this opportunity to receive feedback from students. We asked what they enjoyed, what they would do differently, what mentors could do differently and more. The feedback questions and process were not designed as a formal assessment, but like most of this program were created on the fly. Students were asked to answer at least four of the following questions based on their own preferences.

1. What did you like most about your project?
2. Briefly describe your experience and any benefits of the program and/or experience to you.
3. What would you do differently if you could go back and do it again?
4. Compare your experience to a company internship (or what you expect an internship might be like).
5. What could the mentors do to enhance your experience?
6. How could meetings and engagement with scholars be improved? What went well?
7. What part of your experience would you consider to be the most impactful to your future and why?
8. If you want to comment on anything else, please do so here.

We received feedback from 11 of the 16 students and we are in the process of reviewing all of the feedback which will be used to help shape the program for next summer. As was expected based on the comments and interaction during the group sessions the overall feedback is positive. Below we have paraphrased some of the comments that stood out.

Q: What did you like most about your project?
The students liked they were given free rein on the projects and they could actually take the lead and design something. It felt more like a research project. They also liked the flexibility to accomplish the tasks at their own pace. Some liked the educational focus of the projects and the prospect of getting others interested in our fields of study and helping them learn. Through their own experiences, they could see the relevance and benefit of the projects. Students liked working with faculty and other students in research groups and discussing projects and issues in group meetings. They found the environment to be supportive and friendly, helping them broaden their horizons.

Q: Compare your experience to a company internship (or what you expect an internship might be like).
The overwhelming majority of the comments were about the openness of the project and that they could be creative with the solutions. They were not tied down to a specific set of tasks as part of a large project. They found more opportunities for innovation. Being less prescriptive than most internships, the projects helped students advance as self-directed learners and problem solvers. Some thought it felt less intimidating than a company internship.

Q: What part of your experience would you consider to be the most impactful to your future and why?
They liked learning about how to communicate with people at different skill levels. They could see how that skill would be useful in work and in everyday life. Some projects gave students

experience with new tools that they will use in industry. Students liked seeing how a project starts from scratch. Students also felt that managing their own work and adapting to changes during a project will help them on future projects.

Impacts of the Projects

While it is hard to measure the overall impact of the projects we can provide some details about a few projects that are either continuing or made an impact. At least 5 of the 16 students have been retained on a research project as paid undergraduate researchers. This was a side benefit that we did not think about going into the project. Faculty were able to find good students that would continue to help with their research and students are able to continue their internship through the year. Projects 1 and 9 are continuing through the year and a student on project 6 is taking on a related project during the year.

The two students involved in project 1 (Lab Environment to Support the Cyber Security Essentials Project) are continuing to develop the lab environment (www.hackerville.org) with a goal of using it for a virtual workshop in December. The lab is also being released as part of the cyber security curriculum for high school students. Over the summer the two students were able to stand up parts of hackerville and work through several issues. As they continue through the fall semester they will focus on getting several lab experiments defined so we can start to get feedback from teachers. Hackerville will become a key component of the security literacy project (www.security-literacy.org) at ISU [27]. The security literacy materials have been adopted by around 30 schools across the country and are being offered statewide in two states. The students will also be involved in the expansion of the project into a minor at ISU in cyber security essentials.

The students in project 9 (Development of High School Cyber Defense Competition Curriculum) have released their videos as part of a statewide high school outreach program called IT-Adventures [28, 29] (www.it-adventures.org). Iowa State University is a leader in cyber defense competitions and hosted the nation's first high school competition in 2006 [30]. In the past the program has relied on in-person mentors to support the learning. We provided the mentors with learning materials design to be delivered in-person. The goal of this project was to develop video based learning modules that could be used in a flipped delivery with virtual mentors. The students are now developing lesson plans and other materials to support teachers and students throughout the school year. As with all of our materials they are being made available to anyone. In addition, the videos and materials will also be used to help new students prepare for the Iowa State Cyber Defense Competitions [31]. Again before the pandemic we held in-person help sessions for students new to the competition. This year we are limited in the type of face-to-face interaction and so these videos will be used to help students prepare for the fall Cyber Defense Competition. A student on project 6 will be working on a virtual robot to support the smart-IT venue in the IT-Adventures program.

Lessons Learned

We were actually quite surprised at how well the program worked given limited time for planning. We did have several issues mostly around dealing with payroll and the ISU

administrative and HR system, however in the end ISU worked hard to make this happen. The overall conclusion is that the SECURE program was a success and it should be continued.

We have concluded that virtual internships while not ideal can work. Based on the feedback we will spend more time designing the weekly large group meetings to add more structure especially if the program remains virtual. The students were fairly interactive during the weekly group meetings and offered suggestions for improving them.

We will improve information sharing at the start of the program to explain the deliverables up front for the students and expectations for the mentors. The students did like the open endedness of the projects but would have liked to know up front about the posters and videos. We did decide to add the poster and video part way through the project in part so the students would have an artifact they could refer to and we had something to help promote the program.

We will add more social time if the program remains all virtual. Students were craving interaction which was evidenced by the chatting that took place during the weekly Zoom meetings.

All of our faculty mentors had experience with working with undergraduate students and did not need much support. As we look forward to the future we might need to provide resources to support newer faculty members that have not worked with undergraduate researchers.

Future Work

While the SECURE program was created to respond to the effects of the pandemic we have plans to continue the program next summer. Going forward SECURE will not be a replacement for student internships, but will provide an opportunity for students that might want to focus on an educational project or for other reasons might want to stay on campus. Our goal is to raise funds from donors and companies to support a small number of students. At a cost of about $9,000 per student with overhead, we hope to raise enough to support 5-10 students next summer and then assess the interest and need going forward.

We will also be able to better design the program and the weekly group meetings to provide more structure for the students. This is based on student reflections where some students indicated the desire for weekly agendas and milestones instead of one large deadline at the end. We did get positive feedback on the sessions and the topics. The program team will develop a more purposeful set of sessions with materials to help facilitate the discussion.

We also intend to move some of the overall project management to staff positions in the department.

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References

[1] D. Rover, J. Zambreno, M. Mina, P. Jones, and L.L. Chrystal, “Evidence-Based Planning to Broaden the Participation of Women in Electrical and Computer Engineering,” Proc. 2016 IEEE/ASEE Frontiers in Education Conference, Erie, PA, October 2016. doi:10.1109/FIE.2016.7757643.

[2] D. Rover, M. Mina, A. Herron-Martinez, S. Rodriguez, M. Espino, and B. Le, “Improving the Student Experience to Broaden Participation in Electrical, Computer and Software Engineering,” to appear, 2020 IEEE/ASEE Frontiers in Education Conference, virtual, October 2020.

[3] Iowa State University Information Assurance Scholarship of Service Program - Renewal, Award Abstract #1303279, National Science Foundation. URL: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1303279

[4] W. Parry, “COVID-19 Shakes Up Summer Internship and Research Opportunities: How companies, research experiences, and undergraduate students are adapting,” inChemistry, American Chemical Society, June 24, 2020. URL: https://inchemistry.acs.org/content/inchemistry/en/careers/impact-of-covid-on-internships.html

[5] V. Sloan, R. Haacker, R. Batchelor, and C. Garza, “How COVID-19 is affecting undergraduate research experiences,” Eos, 101, June 18, 2020, https://doi.org/10.1029/2020EO145667. URL: https://eos.org/science-updates/how-covid-19-is-affecting-undergraduate-research-experiences

[6] M.A. Griep and L. Watkins, "Overview of Best Practices for Chemistry REU Programs," ACS Symposium Series, American Chemical Society, 2018. URL: https://pubs.acs.org/doi/pdf/10.1021/bk-2018-1295.ch001

[7] B. Rincon, "Research Experiences for Undergraduates: Current Best Practices," Math Alliance Research Study, Issue Brief #2, July 2013. URL: https://education.illinois.edu/docs/default-source/stem-alliance-documents/alliance_reus_brief_final.pdf

[8] Andrew P. Minigan, "The Question Formulation Technique for Research," Resources, Right Question Institute, URL: https://rightquestion.org/resources/question-formulation-technique-for-research-elements/

[9] Jeffrey H. Dyer, Hal Gregersen, and Clayton M. Christensen, "The Innovator’s DNA," Harvard Business Review, December 2009 Issue. URL: https://hbr.org/2009/12/the-innovators-dna

[10] S. Purzer, N.D. Fila, and A.S. Bohlin, “NSF CAREER: Towards a framework for engineering student innovation,” Proc. 2017 ASEE Annual Conference & Exposition, June 2017.

[11] N.D. Fila, and S. Purzer, “Exploring Connections between Engineering Projects, Student Characteristics, and the Ways Engineering Students Experience Innovation,” Proc. 2017 ASEE Annual Conference & Exposition, Columbus, Ohio, June 2017. https://peer.asee.org/28326

[12] N.D. Fila, R.E. Friedensen, M. Mina, and B. Ahn, “Making Sense of Gender Differences in the Ways Engineering Students Experience Innovation: An Abductive Analysis, Proc. 2018 ASEE Annual Conference & Exposition, Salt Lake City, Utah, June 2018. https://peer.asee.org/30784

[13] J. Dyer, H. Gregersen, and C.M. Christensen, The Innovator's DNA: Mastering the five skills of distruptive innovators, Boston, MA: Harvard Business Press, 2011.

[14] N.D. Fila, J.L. Hess, P.D. Mathis, and S. Purzer, “Challenges to and Development of Innovation Discovery Behaviors Among Engineering Students, Proc. 2015 ASEE Annual Conference & Exposition, Seattle, Washington, June 2015. https://peer.asee.org/23677

[15] Kai Kight, Innovation Keynote Speaker, URL: https://www.kaikight.com (Kai Kight, ASEE 2020, June 22, 2020, https://www.youtube.com/watch?v=kmgOVcf6KAE&feature=youtu.be)

[16] Present Your Research, Undergraduate Research, Iowa State University, URL: https://www.undergradresearch.iastate.edu/for-students/present-your-work (Presentation Resources, https://www.undergradresearch.iastate.edu/for-students/present-your-work/presentation-resources)

[17] Speaker Series, Louis Stokes Midwest Regional Center of Excellence, URL: https://lsmrce.org/students/speaker-series.aspx (Abstracts and Posters, https://youtu.be/MnPww4O_I6s)

[18] H.A. Charlier et al., "Poster Presentation Basics and Blunders," Undergraduate Research Conference, Boise State University, April 16, 2010. URL: https://www.youtube.com/watch?v=cRNQjo2IstY

[19] G. Hess et al., "Giving an Effective Poster Presentation," The Graduate School at NCSU, Preparing Future Leaders Program, February 8, 2013. URL: https://www.youtube.com/watch?v=vMSaFUrk-FA

[20] Greg Foot, "Talking Science: An Introduction to Science Communication," YouTube Course, URL: https://www.youtube.com/playlist?list=PLD160RWuGai9oUnAVRq-GD2njEo1XHadF

[21] B. Wai-Ling Packard, Successful STEM Mentoring Initiatives for Underrepresented Students: A Research-Based Guide for Faculty and Administrators, Stylus Publishing, Sterling, Virginia, 2016.

[22] B. Wai-Ling Packard,"Resources," Mount Holyoke College, URL: https://commons.mtholyoke.edu/beckypackard/resources/

[23] B. Wai-Ling Packard, "Quick Summary on Inclusive, Intentional Mentoring," Mount Holyoke College, April 2016. URL: https://commons.mtholyoke.edu/beckypackard/wp-content/uploads/sites/85/2016/04/RevisedInclusiveMentoringHandout2pages_Packard.pdf

[24] B.L. Montgomery, "From Deficits to Possibilities: Mentoring Lessons from Plants," Public Philosophy Journal, Spring 2018. DOI: 10.25335/M5/PPJ.1.1-3

[25] "Retain Engineering Students with Faculty-Student Interaction," Engage Engineering, URL: https://www.engageengineering.org/fsi/takeaction

[26] "Mentoring and Diversity: A Handbook for Faculty Mentoring LSAMP Indiana Students," LSAMP Indiana, Purdue University, 2007.

[27] J. Idziorek, M. Tannian, D. Jacobson, “Teaching Computer Security Literacy to Students from Non-Computing Disciplines”, Proceedings of the 2011 ASEE Annual Conference, Vancouver, B.C. 26-29 June, 2011.

[28] J. Rursch, A. Luse, and D. Jacobson, “IT-Adventures -- A Program to Spark IT Interest in High School Students using Inquiry-Based Learning with Robotics, Game Design, and Cyber Defense”, IEEE Transactions on Education, Vol. 53, Issue 1, pages 71-79, 2009.

[29] J.A. Rursch and D. Jacobson. “This is child's play - Creating a playground (computer network testbed) for high school students to learn, practice and compete in cyber defense competitions,” Proceedings of Frontiers in Education Conference, Oklahoma City, OK, Oct. 23-26, 2013.

[30] D. Jacobson, “Computer Security Summer Camp for High School Students”, Proceedings of 2006 American Society for Engineering Education Conference, Chicago, June 18-21 2006.

[31] D. Jacobson, and N. Evans, “Cyber Defense Competition”, Proceedings of 2006 American Society for Engineering Education Conference, Chicago, June 18-21 2006.