A Framework for Socially-Relevant Service-Learning Internship Experiences for High School Students

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ABSTRACT

By age 15 girls start to lose interest in STEM, and less than 50% consider a STEM-related career. Providing hands-on internship opportunities has been one of the leading ways to help connect students with exploring computing careers; however, these opportunities are limited in high school. We propose a framework for a university-led high school internship initiative that focuses on service learning, co-design, and the propagation of engaging computing curricula for younger audiences. We piloted this model virtually in summer 2021, with high school students and teachers as interns mentored by university role models. Teams led the development and implementation of computing-infused curricula for a virtual summer coding camp. In this article, we share our framework and review the importance of service-learning for recruiting diverse participants and the use of co-design as a way to broker relationships between developers and community stakeholders. Additionally, we provide preliminary outcomes of our internship model on student and teacher participants gathered from qualitative data including end-of-summer presentations and post-program interviews.

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CCS CONCEPTS

• Social and professional topics → Informal education; *Computer science education*; *Model curricula*.

KEYWORDS

high school internship, tiered-mentoring, service learning

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1 INTRODUCTION

A 2008 study of 1,400 team members found that gender-balanced teams were the most likely to experiment, be creative, share knowledge, and fulfill tasks, while teams with a slight majority of women (60%) were also the most confident [24]. Unfortunately, according to 2019 data points, women only make up 19% of computer software engineers and 20% of computer programmers, which echoes the percent of computing and information science baccalaureate degrees earned by women (26%) [19]. There have been numerous papers referring to the leaky pipeline, recruiting, and retention problems in computing [34, 35]. However, the window to increase girls’ interest in computer science is fairly short, with a 2017 study across 12 countries and 11,500 women between the ages of 11 and 30 having found that girls’ interest in STEM careers begins to wane by the age of 15 [46]. Furthermore, as of 2019, less than half of U.S. high schools teach computer science courses [12] leaving a wide gap for students who may be interested in computing but who lack sufficient outlets or instructors.

Computer science internship opportunities are associated with higher retention rates, increased interest in computing careers, increased proficiency in technical skills, communication and networking opportunities [22, 28, 30], but these opportunities are limited at the high school level [17, 45, 49], leading students to instead enroll in code camps and other programs that don’t necessarily facilitate the same level of agency, daily work habits, or career understanding. Practical, hands-on experiences with projects that impact society or the greater community have been specifically shown to increase women’s interest in related careers [16, 23, 37]. Through creating a multilevel internship program in our computer science department, our program staff have facilitated tiered mentorship from computer science graduate students and faculty to our summer interns (both high school students and teachers) as they develop socially relevant and culturally situated programming activities for K-12 classrooms. Through a collaborative effort with our college’s summer camp infrastructure, our interns were also able to pilot some of their applications and curricula, allowing them to complete a project pipeline cycle from client ideation to release.

In this paper, we review the theories behind our framework, present the framework mechanisms, then provide preliminary outcomes of our internship model on student and teacher participants gathered from qualitative data including end of summer presentations and post-program interviews.

2 LITERATURE REVIEW

2.1 Theoretical Underpinnings

2.1.1 Service Learning. Service learning is an increasingly common framework utilized in education that places teaching and learning in a social context [14]. Participation in service learning has been found to have positive effects on academic, personal, and social outcomes [14]. Academic benefits include content knowledge, the ability to apply this knowledge, and increased motivation to learn [14]. Personal and social outcomes include leadership skills, self-efficacy, and career development [14]. A longitudinal study of over 20,000 undergraduate students at 19 institutions found that engaging in community service and/or service learning resulted in positive effects on critical thinking skills, commitment to activism, self-efficacy, leadership, and plans to continue participation in service [2]. Research on the STARS Computing Corps alliance, showed that students who spend over 40 hours on service are likely to experience the greatest gains from participation in computing outreach/service learning, including leadership skills, increased computing identity, and self-efficacy [15]. These results suggest that service learning not only directly benefits students, but creates a lasting effect in their communities from the inclusion of socially active citizens continuing to participate in service. *2.1.2 Student Motivations.* Expectancy-value theory [1, 20], suggests that students who work on meaningful projects with a belief of succeeding will have more motivation to learn and accomplish, especially when embedded in a supportive environment [1]. Research has shown that women often place great value on social activism [44] and that female and minority students are inclined to pursue careers that they perceive as being helpful or having a positive impact on the community [3, 10, 38]. These fields typically include service-oriented work like Counseling, Social Work, and Health Services [10]. This interest in being part of positive social change is a significant factor in the CS gender gap [44].

Introducing students to role models and providing positive interactions with computer science through activities outside the classroom are important strategies for promoting participation in the discipline [11, 47]. The use of identity based role models has been shown to influence career choice, as individuals look at role models and compare their own situations and experiences to those of the role models [39]. This kind of comparison is associated with an evaluation of their own abilities, motives, and what they could achieve in the future [5, 9]. According to the identity-based motivation (IBM) model, youths’ perceptions of what is possible for them and others of their identity group often affects what goals and educational opportunities they pursue [36]. Similarly, one of the central underlying themes of the learning sciences is that students learn deeper knowledge when they engage in activities that are similar to the everyday activities of professionals who work in a discipline [43]. Roth suggests that internships reflect activities of actual professionals in the field where, among other criteria, students must encounter open-ended tasks, engage in practices used by professionals alongside professionals, and be able to ask for help from others (peers, advisors, or teachers) [41]. Within computer science these practices revolve around software engineering and product development, including, rapid prototyping, peer review and scrum [33, 40].

2.1.3 Pedagogical Co-designers. Curricular co-creation, the development of educational software and curriculum for K-12 classrooms by students, is a form of project-based learning and cognitive apprenticeship where learners apply and learn disciplinary ideas and skills to investigate and solve meaningful problems [13]. This curriculum creation activity also situates computing as a problemsolving tool that benefits the community through socially relevant computing topics which can serve as a pedagogical tool to recruit new students into the discipline [8]. The benefits of curricular co-creation include new approaches to student engagement and learning experiences informed by prior student experiences which may produce lessons that students find more relevant and authentic [7, 48]. By positioning interns as pedagogical co-designers [6], they are charged with using CS to make an impact in their communities, which helps to promote sustained engagement in CS and in STEM in general [11, 25, 31, 44].

Prior work showed that teachers’ program requests included development features that were beyond interns’ initial understanding and required them to puzzle out solutions [27]. Findings from Järvelä et al. also suggest that when working with meaningful content, learners are likely to persist in challenges that surface because they have identified something for which they want an answer, are curious about, and are working to address it [29]. Furthermore, when participants take more ownership in an initiative, they are more likely to display leadership skills resulting in individuals being more engaged and energized [42].

2.2 Related Work in Computing Education

Ours is not the first framework to propose computer science internship experiences for high school students [17, 45, 49]. The 8-week Glitch Game Testers internship focused on the specific career of Video Game Testing and had 12 African American male participants ages 16-17 [17]. The program goals were to offer free testing for game companies in the summer so that interns could get hired on in the fall. This experience gave students greater insight into the gaming industry and the different elements involved, but also led interns to be less interested in a career where they ‘play video games all day’, citing the job as ‘tedious’.

Internship programs like Girls Embrace Technology, DigiTechnikum, and Flames have been shown to increase participants’ interest in computing [26, 45, 49]. Girls Embrace Technology (GET) was a 6-week high school internship where 36 girls collaboratively developed hands-on educational software to teach science phenomena to elementary school children [45]. Researchers and organizers of the program report that throughout the course of the internship, the students’ misconceptions about the field (that it wasn’t collaborative, creative, or rewarding) were clarified with authentic insight into technology-based careers. Consequently, these students also began to imagine themselves pursuing careers in technology. The

GET program combined student learning of real-world technical skills in an authentic industry-modelled experience with a serviceoriented project that allowed students to see how computer science could be used to help others.

Newer programs like DigiTechnikum and Flames have students choose their own socially relevant topics that they want to create solutions and technology for [26, 49], with Flames listing K-12 classrooms as the intended audience. These programs model industry practices and structure while allowing students' agency to choose their own development projects. DigiTechnikum teaches students about organizational industry practices such as Kanban boards and Flames focuses on the agile development process, featuring sprints and daily scrum meetings. An interesting aspect of DigiTechnikum is that the students are required to find their own clients or needs in the community by surveying persons nearby the host university.

2.3 Initiative

Taken together, these educational theories and internship practices provide a backdrop for our proposed model. Through using educational themes and benefits to the K-12 community, our internship framework aims to augment student perceptions on computing, addressing misconceptions and stereotypes students may have about CS. This can help to address the gender gap in CS by showing young women that CS is interesting, collaborative, and socially-relevant and that they have a place in the discipline [31, 32, 38, 44]. The proposed framework intentionally focuses on developing a sense of belonging, and providing participants structure and community to ask for help from each other, graduate students (including their mentor), faculty and staff. By leveraging best practices for increasing self-efficacy and motivation, this framework aims to engage and support new students in CS and continue to support those who are already engaged such that they deepen their interests and as a result their motivation to continue in the computing discipline.

3 THE MULTILEVEL INTERNSHIP MODEL

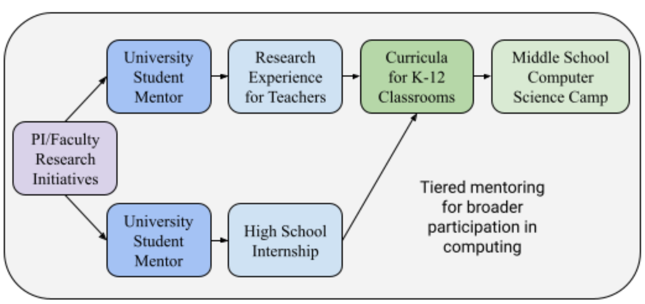

Figure 1: The Multilevel Internship Framework pairs high school interns developing their coding skills with teacher interns developing their subject matter expertise to create innovative computing curricula for K-12 classrooms.

In this section, we present the multilevel internship framework which combines service learning with practical hands-on experience (see Figure 1). The first tier of the framework is the PI/Faculty lead which is hosting the program participants. The PI provides guidance and mentorship to the university students as part of their regular supervision and advisory position. The next part of the framework matches university students with their respective mentees who are looking to develop their computer science or research skills. This model utilizes the 6-week Research Experience for Teachers (RET) program sponsored by the National Science Foundation [21], which aims to provide STEM classroom teachers with research experience in engineering and computer science so that they may translate their research experiences and new scientific knowledge into their classroom activities and curricula. Given that the teachers are often busy with the research side of their summer experience, it is hard to balance both research expectations and curriculum development in the 6-week duration of the program, often leading RET teams to postpone development until the final week or after the termination of their program. Furthermore, as the teachers come from broader STEM disciplines and not necessarily computer science, their programming skills vary greatly. Introducing high school interns to fulfill the RETs' coding/curriculum project requests helps build high school students' technical skills and knowledge while alleviating pressures on the RET and generates engaging curricula for K-12 classrooms. In this process, the teams meet to discuss requirements and design decisions, the high school interns develop the projects for review by the RETs, and make refinements before deploying the material in a summer camp run at the university. The following subsections expatiate each of the roles and mechanisms to the internship program.

3.1 High School Interns

As part of a 6-week virtual high school internship program, computer science interns develop computing-infused curricula for K-12 classrooms in intern cohorts and while working with teachers. Although each intern has prior coding experience (Scratch, Python, Java, etc), in the first week of the internship, interns participate in a pedagogy and coding bootcamp, experiencing computing-infused lessons as learners and attending presentations on topics such as computational thinking, scaffolding, universal design for learning, project based learning, assessment, culturally relevant pedagogy, and socially relevant computing. Afterward, interns begin a development sprint model until the internship ended. For the sprints, interns can work individually or on a team and could either create lessons based on their own ideas or work to fulfill teacher requests. Feedback from our prior high school internship program showed that interns wanted additional opportunities to work closely with clients to develop their requests. By collaborating with the RET program, we are able to provide these opportunities for interns to work directly with teachers to co-create lessons for classroom use.

Each week, interns organize into project teams and are expected to create one computing-infused lesson which they would then present on Friday in a project showcase. After the project showcase, interns conduct peer code reviews and would provide peer feedback to one another about their lessons. Leading up to the Friday showcase, interns have flexibility in their work hours and attend daily check-in meetings, modelled on industry scrum meetings, where they share their progress with a graduate student mentor. Additionally, the internship program hosts weekly tech talks and “Wonder Workshops" where interns are taught new coding techniques.

3.2 Research Experience for Teachers

In RET programs, participants are paired with a research mentor and university student. Together this team conducts research over the course of 6-weeks before sharing final presentations. RETs are not expected to complete an entire research project from ideation to publication, but are instead joining an active research group who may focus on study implementation and analysis, or reviewing the field to help direct later research activities.

Furthermore, RETs are charged with distilling their experience into new curricula activities that can be implemented in their classrooms to help engage diverse students and encourage them to pursue science, technology, engineering, and mathematics fields. To facilitate this, RETs attend both discipline specific and teaching oriented workshops to help build their skills needed for teaching advanced concepts in the classroom.

3.3 University Student Mentorship

University mentorship is important to keep the partnering teams on track. Utilizing video conferencing software provided by the university, RET teams set daily check-ins with their university mentors centered around project planning. The high school interns frame their daily check-ins as scrum meetings following agile industry practices. The check-ins have a simple agenda of seeing what each team member is working on, what roadblocks they might be running into, and what sort of help or additional support they need.

The group’s weekly meetings are generally longer, and focus on specific technical/pedagogical skills. Both interns and RETs attend workshops on block-based code development, piloting existing infused-curricula, learning about universal design and accessibility, as well as on aligning their activities to state or national learning standards. In these meetings the university mentors would lead the participants through active learning, demonstrations, and group discussions to facilitate deeper understanding so that they might make connections to their personal projects.

The final structure provided by the mentors relates to goal setting and timelines. The 6-week duration of the program is short, and therefore requires good organization to fully utilize the time involved. The student mentors are able to practice project management, delegation, and decomposing their work into manageable parts which are all desirable skills for future research leaders.

3.4 Collaboration & Summer Camp Pilot

In our model, we include an opportunity for teams to pilot their curricula in a CS summer camp hosted by the university. Teams are given a 1-day session (typically 3.5 hours) to pilot their materials as desired. Typically, they introduce the new topic, lead the campers through an unplugged activity [4] to explore underlying concepts, then begin a guided coding activity which is followed by the opportunity for campers to choose their own extensions and create something on their own or with a friend. This short experience gives RETs immediate feedback on their designed activities before a traditional classroom pilot during the academic year. By leading their curricula in camp and discussing with the other teams and teachers, each group is able to identify gaps in their lessons where scaffolding should be added to support varying learners.

In their collaboration, RETs are paired with the high school interns who act as the developer contractors. After submitting their curricula proposals to the larger intern program, the RETs meet with their selected intern collaborators 2-3 times as needed to provide clarifications, suggestions, and other feedback. For the high school interns this experience gives insight into client relations and eliciting program requirements. Through the feedback cycles with the RETs, interns refine their products multiple times prior to ‘release’ on the camp date where they receive additional user feedback information. Several of our intern developers also took part in the camp instruction leading small groups of campers in the activities using breakout rooms. This synergistic combination of RETs and interns also contributed to the success of the camp by showing the interns as near peer role models who were in active internships working for authentic clients to deliver completed products. Several of the campers were astonished when they found out the coding activities were developed by high school students.

4 PROJECT EXAMPLES

In this section, we share some example projects made during the high school intern and RET collaborations. AP Computer Science A example - *Inheritance with Makeup*

To teach inheritance in AP CS A (Introduction to Java), three of our interns designed a makeup applicator program. Teachers would provide lipstick as an example class of makeup, and students would be responsible for adding other cosmetics. This activity utilizes a theme that has been otherwise overlooked by our research team due to potential concerns about being too stereotypical or not representative of female engineers; however, the intern creators found the theme of makeup to be relevant to their youth and much more engaging than the materials they saw in their existing classrooms. To quote an intern,“[I enjoyed] being able to bring something a little more creative into the class because some of the projects I’ve done in the past have been kind of boring and I think I would be super intrigued if I had been presented projects like this before."

Social and Emotional Learning examples - *Pronoun Usage, Breathwork Techniques* These activities were developed for an AP CS Principles teacher who was transitioning to teaching Social and Emotional Learning (SAEL) at their high school. The Using Pronouns project is designed as an interactive narrative that educates the user on pronoun usage and showcases different scenarios between characters and which pronouns to use. It is an introductory activity that lets students create their own avatar to add into the narratives to better represent themselves. The second SAEL lesson (Figure 2a) walks students through 3 different breathwork techniques to *ground*, *calm*, and *energize*. The instructors first lead the class in physically completing a grounding breathwork technique so they understand the use and intentions of breathwork. The activity then uses computational thinking concepts like abstraction, pattern recognition, and algorithms [18] to introduce students to the coding environment and starter code. Next, students program a breath animation of an expanding and contracting circle and are additionally given time to integrate their avatars.

(a) Breathwork Activity (b) Water Supply Chains

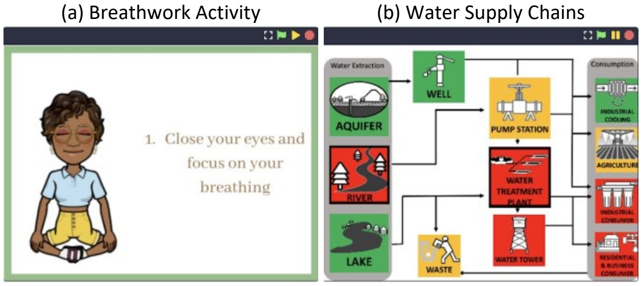

Figure 2: Example curricula made by intern/teacher teams

Food, Energy, and Water Systems - *Supply Chain Models* Another example project is the Food, Energy and Water Systems project (Figure 2b created for an RET team working with a Geospatial Analytics Research group. This project introduces students to the Water Systems Pipeline by having them complete logic puzzles and small coding problems to resolve malfunctions in the pipeline. The students are given pseudocode and practice translating it into Snap*!* code blocks. In the final portion of the activity, students gamify the Water Supply Chain by adding in characters such as zombies, heroes, aliens and explosions. This project aligns with the learning objective to use models and simulations to explore and program a real-world problem known as the Water Supply Chain.

5 PARTICIPANT PERSPECTIVES

5.1 Intern Perspectives

Overall, 18 of 35 high school interns (16 female, 2 male) self-elected to work with the RET teams on their requests; interns who elected not to work with RET teachers instead worked on creating coding lessons from their own ideas. Twelve interns worked with an RET team on culturally-relevant APCSA lessons while 4 interns worked on breathwork and pronouns lessons and 2 interns assisted with a supply chain lesson. We conducted interviews with 11 interns who worked with the RET teams to better understand the intern perspectives toward this collaboration and share our findings below.

First, interns reported that working with the RETs was a positive experience. They found the teachers to be supportive, enthusiastic, encouraging, and relatively easy to work with as they provided useful guidance and feedback throughout the process. One intern shared, "The great part was [the teacher's] enthusiasm and that they wanted to have this in their curriculum. I thought that was super cool." Another intern reflected on the valuable feedback incorporated in the process, sharing that one of the most rewarding experiences of the internship for her was "working with the teachers for the AP CSA lesson and kind of taking the criticism or working with that and seeing 'how can I make this better' and just seeing how we can make our best project." Though interns definitely appreciated receiving feedback from the teachers, there were a couple instances where teachers' feedback and requested changes to the lessons were not timely and resulted in interns having to rush to implement the changes. In future implementations we encourage teachers to be aware of upcoming deadlines to provide more timely feedback and reduce potential stress to the intern developers.

Many interns identified that they developed teamwork, communication, and other collaboration skills through working with the teachers and as a result of the larger internship program in general. One intern shared, "The lesson making experience that I enjoyed the most was definitely the AP CSA project, because in that project, I was able to not only collaborate with teachers on a one-on-one basis, I was able to work with a partner. And throughout those experiences I was able to grow both my teamwork abilities and was also able to learn how to take in feedback and then enhance the project." Additionally, some interns felt that they gained a sense of 'professionalism' from working with the teachers, or likened the teacher-intern collaboration to scenarios they might encounter in the workplace. One intern elaborated on the workforce development skills she gained and the importance of working with the teachers, stating "It was like a company thing. It's like when you graduate college and ... you're actually working and ... it was back and forth email, ... like last minute things and learning how to present to a group of people you've never talked to before and it just felt like workforce experience that I really liked... I think that my most learning experience came from those moments where I was actually having to put my learning to show."

Interns found the real world impact of the lessons as an incredibly important aspect of the RET collaboration. Although other studentinitiated lessons are added to a community repository, there isn't a guarantee that they will be used in classrooms. Interns collaborating with RETs, however, knew for sure their lessons would be used in a classroom, making their collaboration with the teachers very impactful. One intern shared "I really liked [working with teachers] because it made me feel more like I really accomplished something..." Another said, "I honestly think I preferred working on the AP CSA lessons because I know that my programs are going to be used." A third intern shared that the most rewarding part of the internship for her was collaborating with the teachers because she was able to "know that our work efforts throughout those meetings were actually helping teachers improve their [own] lessons... So that was really interesting to see how we could apply our knowledge to something that would actually be used in their curriculum."

Interns also really appreciated the approaches that the teachers were taking toward the curriculum and that they were making efforts to incorporate culturally- and socially-relevant examples and topics in the lessons. In addition to a desire to work with teachers, interns elected to work on teacher requests in part due to their topics. For example, two of the interns working on the pronouns lesson had previously utilized their passion for LGBTQ+ rights and history to make a Stonewall Riots focused project, and were drawn to the teachers' request due to its topic. Many of the interns working on the AP CSA lessons were also excited for the opportunity to create culturally-relevant computing lessons. One of these interns declared, "it was really cool to incorporate cultural relevance to our projects. Because our AP CSA was geared more towards women to make them feel more comfortable in a predominantly male field. And yeah that is really cool how we could teach a subject like inheritance but at the same time empower women in STEM with the same project. I think that was my favorite thing I learned."

For those interns who were able to assist with the middle school camp and see their curriculum in action, this opportunity was incredibly rewarding. In fact, two of these interns said it was the most rewarding part of the entire internship for them. One elaborated further on the impact of that experience, stating "Definitely working with the middle schoolers on the second day [of the camp]. I was in a breakout room and I was working with three or four other boys. And they seemed so interested in what they were doing and they had so much fun like scaffolding and changing up the code, writing their own. And their reaction to seeing their own bitmojis in the code was so much fun. They're like 'oh my god that's me, like I did that', and so that was a lot of fun."

5.2 Teacher Perspectives

We had two RET teams work with our high school interns, Team 1: Socially and Culturally Relevant Computing and Team 2: Food, Energy, and Water Systems (FEWS). Team 1 was further split into two target courses, AP Computer Science A and Social and Emotional Learning. The 5 participating teachers came from a variety of backgrounds, all of which included teaching CS to K-12 students. Their other teaching experiences varied including: Business, Health Sciences, Biology, and Earth and Space Science. All but one used at least one block-based programming language in their teaching.

Team 1 worked with a research scientist focused on culturally responsive computing and social justice. The team included three in-service teachers, and a CS graduate mentor. They chose to create inclusive activities in order to relate to underrepresented groups in computing. In collaboration with the interns, the team created two SAEL Snap*!* coding lessons as described in section 4, and six culturally responsive Java projects. The later projects include, Searching, Sorting, and Recursion using school racial segregation data; Strings and Iteration using Nasi Lemak and family recipes; Arrays, ArrayLists, and 2D Arrays using state and country immigration and demographic data; Data types, Variables, and Conditional Logic using movie ratings; Objects, Classes, and Methods using a Twitter simulator and social media injustice; and finally Inheritance using makeup types and application. In total Team 1 worked with 5 intern teams (14 girls, 2 boys).

Each of the RET members were grateful for the interns' help. The AP CS A lead stated, "All of the students were amazing and did great work. They worked hard and put together a great set of resources for unit projects..." Without the help of the interns the four-person RET team would have been unable to build so many activities while maintaining their research responsibilities. The two teachers working on the SAEL projects found the interns to be "truly exceptional humans." One teacher stated, "All of the interns participating in this project exhibited: integrity, passion for learning & sharing CS, open-mindedness, and willingness to co-create in a group. [They are] able to troubleshoot individually and as group member —Personally, I would co-create with any of them again."

The FEWS team had similar feelings after working together with their interns. Composed of two teachers and a CS graduate student mentor working on supply chain reliability, the teachers wanted to be able to introduce their classes to FEWS through modeling and simulation using computing. This team worked on a singular Water Supply Chain activity described above with the help of two female high school interns. From one teacher,"They both did a fantastic job coding our complex task with booleans/decision/iterative statements with tons of broadcasting in order to create a simulation of a water supply chain. They also explored resources and experimented so we could gamify the system and show examples... to inspire our campers." One teacher was so impressed with interns, that they told them "to contact us to pursue the NCWIT awards and I would be a recommender." The teacher goes on to explain, "these ladies did more work than anyone and met with us almost every day and I am sure we could not have accomplished phase 2 without them." The teachers originally started a lesson directed by their faculty mentor on pharmaceuticals, but found the concepts and requested projects to be "too complex to be used in a high school classroom." They were much relieved to be joined by the high school interns.

6 DISCUSSION

As suggested by prior research [1, 14, 15, 20, 44], providing socially relevant and service-oriented internship experiences for young women where they can see the immediate impact of their work, reaffirms and deepens their computing identity. As pedagogical codesigners, our interns were able to create meaningful projects for their clients to promote better student understanding and engagement in future classrooms. The interns participating in the program reflected on their personal growth and ability to use their classroom learning on real-world projects, strengthening their knowledge and skills. A common theme across interns was the similarity to a future career work environment and practicing communication skills such as email and receiving critical feedback. The similarity to a future workplace also included getting urgent requests, which we do not recommend as a best practice. Therefore we recommend providing structured guidelines and expectations for teacher/intern collaboration or encouraging teams to create these guidelines together so they feel a sense of ownership over them and will be more likely to hold each other accountable. However frequent the requests for change were, the interns were energized to make updates and refinements to their products, integrating suggested feedback before release to either the summer camp or teachers' classrooms. When partnering with K-12 teachers in designing materials for K-12 students, the interns become the coding experts and are able to feel a sense of accomplishment in their work.

These findings suggest that a successful internship model could be implemented for high school students especially when the department already runs an RET program. Running an RET program is also beneficial because it helps broaden participation in computing by making a larger impact at the K-12 level by helping to disseminate computing and engineering concepts. For departments not running an RET program, teachers can also be solicited through the Computer Science Teachers Association or from local schools in the community. We note however, many teachers are looking for alternative work in the summer to supplement their 9 month salaries, and the RET program helped to meet that need. Meanwhile, the high school interns were unpaid, but it was still a step up from them paying for an expensive camp or summer school. Furthermore, we have found this model to be successful in a virtual environment, and imagine with more in-person collaboration, the program's benefits would be magnified.

7 CONCLUSIONS

This paper presents a model for a university led computer science high school internship program that pairs high school interns with graduate student mentors, Research Experience for Teachers participants, and university researchers to create socially relevant and meaningful curriculum for K-12 classrooms. This model has been successful at recruiting female participants and encouraging them to use their computing knowledge and skills to help teachers bring innovative computing activities to their classrooms. The model extends the methods used by programs like GET, Flames, and Digitechnikum [26, 45, 49] by giving students freedom to choose their development focus and providing relationships with community partners who desire to work with them on meaningful projects. The model provides students the opportunity to see what research is like, network with similarly minded peers, and to strengthen their computing identities. To help determine quantifiable success of the model, career perception and skills development survey instruments should be analyzed from participants. Our initial qualitative findings from interview and feedback found the model to be beneficial to both interns and RETs given their respective computing experiences.

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