Faculty in Residence: Improving Preparedness of Underrepresented Students in Computing

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***Abstract*— Google's Faculty in Residence (FIR) Program brings together computing faculty from universities serving students underrepresented in the computing industry. Three cohorts of faculty have participated in FIR from 2017 through 2019, for a total of 73 faculty from universities that are either designated as a Minority Serving Institution or that have a significant part of its student population underrepresented in computing. In the month-long, immersive summer program, participating faculty learn about software engineering best practices from an industry perspective, the recruitment, application, and interview process, engage in hands-on project development, and are exposed to the work culture at Google. One theme of the program is the importance of project-based learning and each faculty was tasked with designing and developing a project that they would then assign in their classes. While there was complete flexibility in the design of the project, the expectation was to adopt project-based learning that would support diverse and inclusive classrooms. Another important component of FIR is the recruitment, application and interview process used by Google and companies like it. This part of the program provides faculty with specific practices that they can implement in their classes to improve students' preparedness in applying and interviewing for technical internships and positions. This report summarizes the program, describes the experiences of the authors in the program, and offers recommendations for others to adopt.**

Keywords*— *Faculty in Residence, broadening participation, project -based learning, underrepresented students

I. Introduction

Google's Faculty in Residence (FIR) Program brings together computing faculty from universities serving students underrepresented in computing degrees and careers. Three cohorts of faculty have participated in FIR from 2017 through 2019, for a total of 73 faculty from universities that are either designated as a Minority Serving Institution (MSI) or that have a significant part of its student population underrepresented in computing. In the month-long, immersive summer program, participating faculty learn about software engineering best practices from an industry perspective, the recruitment, application, and interview process, engage in hands-on project development, and are exposed to the work culture at Google.

II. Background

Some of the prior industry-academia collaborations relate to industry sponsored research, industry recruitment of students, and, at some universities, industry advisory boards that can provide valuable insight on a department's curriculum. In certain computing disciplines, such as artificial intelligence, there are significant increases in the level of research interaction between professors and companies, which take the form of extended joint appointments [6]. There is a need for novel, deeper and longer lasting interactions between industry and academia that include cultivating enterprise-driven culture within universities and strong industry informed curriculum design [8]. The FIR program is an effort that seeks to improve the preparation of all students for technical careers, with particular focus on underrepresented students. Another effort is the Googler in Residence (GIR) program that assigns a Google engineer to spend a semester teaching at a Minority Serving Institution (MSI). Both programs, FIR and GIR, had been designed and were in the implementation phase when in 2017, a special session at the SIGCSE Technical Symposium discussed the impact of such programs to support underrepresented students [2]. The special session organizers recognized the need to create and scale efforts like these programs that prepare students for technical careers. The FIR program's model to introduce faculty to industry practices has a wide impact as these faculty reach thousands of students. Like the cohort models that have succeeded in increasing graduation rates of underrepresented students in computer science [7], the FIR program also uses a cohort model to guide faculty towards a common goal and to build an educator community that is improving the preparedness of these students. It is doing so by presenting and training faculty in professional practices and tools used in industry, which can address the knowledge deficiencies found in graduating students [9, 11, 4]. Radermacher and Walia [9], identified and classified "...knowledge deficiencies found in graduating computer science students for the purpose of better preparing students for their future careers in academia or industry". They present the knowledge gaps in several categories with the top deficiencies being written and oral communication, project management, software tools, and testing. More recent publications report on a persisting academia-industry gap faced by recent computer science graduates [11] and how students are having to fill this gap on their own after an internship experience revealed to them that their Computer Science program was not preparing them as expected [4]. Valstar identified that it was "lack of faculty awareness, real vs fake projects, and resource limitations" that leads to the persisting gap [11]. The first two of these causes are

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much of the focus in the FIR program as it seeks to improve the preparedness of students at MSIs. The program improves faculty awareness around technical and professional skills such as problem solving, unit testing, code reviews, collaborative work, and use of professional tools. In addition, we believe the FIR program's emphasis on project-based learning also seeks to reduce the academia-industry gap that is partially due to "real vs fake projects".

III. GOOGLE FIR OVERVIEW

A. Immersion in Industry Work Culture

From the first day of the FIR program, the participating faculty cohort are immersed in the Google culture starting with the excitement of the orientation when each new hire gets a work laptop and a Noogler hat. This immersion in Google's engineering culture continues throughout the length of the program, which includes participating in the first week in several of the onboarding and hands-on training activities required of new hires (whether interns or full employees), joining other Googlers on their team meeting, attending TGIF meetings, and yes, riding the GBikes, and enjoying the free snacks in the micro-kitchens and free food from the many cafeterias and food trucks.

B. Project-Based Learning Focus

Project-based learning is described as a cooperative, student-centered approach to teaching that emphasizes the development of skills through practice, sustained inquiry and facilitated learning through the management of a project or product [1, 5]. A key component of the FIR program is for each faculty to design and develop one or more projects to be used in their classes that (a) captures some of the main learning objectives of the course, (b) addresses a real-world problem interdisciplinary in nature, (c) is guided by the instructor and yet has flexibility for personalization, (d) has students collaborate with one another, and (e) supports diverse and inclusive classrooms. The range of projects designed, developed and implemented by the FIR cohorts has been wide, from a cross disciplinary project aimed at first-year students to solving real-world problems in a data structures course to mobile app development projects to business and entrepreneurship projects. In particular, the projects developed and implemented by the authors of this report include a Contact List project in a Data Structures and Algorithms course where students form teams to implement a contact list via hashing with specifications on goals and outcomes at the same time giving students flexibility to add features and extensions; a Scaffolded Application for a Database course distributed via GitHub Classroom, where students are provided with user interfaces and they develop the backend database work which is unit tested along the way; a cross curriculum CS project development experience that features Google Interviews and learning by example [3] as well as practical hands on work.

Some of the project implementations included subsequent project-related monitoring of student feedback and assessment of outcomes. For example, for the cross-curriculum project, students reported a positive shift in their project development skills and expressed high motivational interest in the related Google interviews and the real world learn by experience examples.

C. Software Industry Best-Practices

Some educators are aware of the importance of such practices as unit testing and of source code version control tools. It is, however, from an academic's perspective. Our experience at FIR sharpened our awareness and expanded it to include the importance of code reviews. Learning that developers write more lines of code to test than they write lines of code that ends up in production, makes you take notice and start planning how to incorporate such skills in your classes.

The faculty participating in FIR incorporated many of these industry best-practices into their projects, such as version control via GitHub or Bitbucket, code review among project partners, unit testing, integration testing, and testing in general. Continuing to practice these skills throughout the curriculum is important in learning and in further advancing knowledge of these skills.

D. Internship/Job Search Skills

Another important component of the FIR program is providing faculty with information on the recruitment, application and interview process used by Google and companies like it. This part of the program supplies faculty with specific practices that they can implement in their classes to improve students' preparedness in applying and interviewing for technical internships and positions. Practices such as resume building, constructing an online profile via LinkedIn and GitHub, whiteboarding, and mock interviewing have been widely adopted by FIR faculty in their individual institutions, often offered through workshops, computer club activities, and one-on-one work with the students. One of the highlights of participating in FIR is the optional opportunity each faculty has to experience a whiteboard technical interview. The personal knowledge gained in this hands-on experience serves to highlight how we share the importance of practicing for technical interviews and training students on key steps to follow during these interviews. One of the most important steps is for candidates to verbally communicate their problem solving approach on the problem to the interviewer. Such verbal communication of the thought processes one uses in solving a problem is rarely practiced in CS classes, yet, it's a critical skill to develop if students are to succeed in technical interviews.

E. Mentorship & Learning Experiences

A distinct feature of the FIR program is the mentorship provided by Google engineers to FIR faculty. Each faculty is matched with and mentored by an experienced Google engineer who guides and provides industry perspectives on the design and development of faculty's projects. The mentor also shares their insights on computer science curriculum, expectations of new college hires, and the Google work culture. Faculty and mentor meet throughout the program and sometimes the mentorship continues beyond FIR into the classrooms. Faculty in the program have the benefit of a visit at their university by the Google FIR Team and mentor to meet with and answer questions from students. It is powerful and motivating for students to hear directly from Google engineers that what they learn in school, such as version control, code review, and testing,

are important and relevant best-practices used every day in industry.

F. Building an Educator Community

One of the successes of the FIR program is the building of a community of educators who are passionate about having their students succeed and thrive in the tech industry. The FIR program is a unique experience bringing together faculty at different levels in their academic careers from universities spread throughout the US – some designated as Historically Black Colleges and Universities (HBCU), some designated as Hispanic Serving Institutions (HSI), others as women's colleges; some granting PhD degrees, others offer only Masters degrees, and while some came from community colleges. There are as many differences in our backgrounds as shared similarities in our professional work, especially when it comes to describing our students. We serve at institutions that have a significant percentage of students underrepresented in higher education [10] and even more so in the computing industry. Many of our students are first-generation, come from low-income families, work long hours to pay for their education, commute to campus, some have families to care for and support financially, and some struggle to make ends meet. Yet, they persevere and sacrifice to earn a higher education. Our students have strong family values, cultural richness and assets that create dynamic learning environments in our classrooms. As we discovered these shared experiences about our students, a bond of community started to form. It is this spawning of an educator community that has stayed with us many months since having completed the FIR program. Like the successes that cohort-based education efforts have with underrepresented students [7], the FIR program's long-lasting success will likely be attributed in part to the supportive educator community created in those four weeks in Mountain View California.

IV. Support of MSIs

To achieve some of the outcomes to address direct support for MSIs, Google instituted a formal partnership agreement with the United Negro College Fund (UNCF) to support Historically Black Colleges and Universities (HBCU) and also partners with the Computer Alliance of Hispanic-Serving Institutions (CAHSI) and Hispanic Serving Institutions (HSI). These relationships attempt to directly impact three specific levels – students, faculty and institution (inclusive of the community at-large). At each level, the partnership will deploy strategies that maximize outcomes and impacts towards the main goals of significantly improving the production of MSI graduates in the computer science and computer science-related ("CS") fields; and, maximizing the yield of African American and HBCU CS as well as Hispanic and HSI CS graduates entering the tech-workforce. These organizations and Google recognize that the significant challenges in the STEM-CS education pipeline and the lack of diversity in the tech-workforce require the development and implementation of a collaborative, partnership-driven and scalable workforce development model in order to increase the yield and preparation of African American and HBCU as well as Hispanic and HSI CS graduates. In addition, a major goal of the partnership aims to transform HBCU and HSI campuses as CS education and training platforms that engage surrounding communities and local K12 education agencies to broaden the impact in a sustainable manner. The strategic approach for the partnership is framed by three pillars:

- Student Engagement, Readiness and Preparation
- Faculty Engagement & Professional Development
- Institutional/Community Capacity Building

The HBCU Innovation Summit founded by UNCF is one shining example of these partnerships. Started in 2013, the HBCU Innovation Summit brings students and faculty to Sillicon Valley for four days to hear from and learn from tech companies – 14 companies in 2018, including Google, eBay, Pixar, Twitter, Adobe, etc. The summit includes workshops, company tours, a career fair, and interviews [12, 13].

In addition, UNCF is responsible for the development of an HBCU CS Center of Excellence which aligns with the specific UNCF/Google Partnership, and will support innovation in computer science education and tech skills development across HBCU campuses; and empower African American students to succeed in college and careers in the tech industry.

V. Reflection

Cultural and family assets of diverse students create dynamic learning environments that need to be nurtured to keep students engaged despite their many non-academic commitments. While many students have grit, they often lack a growth mindset and may question their belonging in computer science. We need to instill in them this growth mindset by creating learning activities that are culturally sensitive, provide continuous feedback, and allow flexibility to complete them, while preparing them with the professional skills sought by tech companies. Addressing the growth mindset via project-based learning has garnered positive feedback as project-based learning is student-centered, with opportunities for them to work on personally meaningful components.

In general the added practices such as resume building, constructing an online profile via LinkedIn and GitHub, whiteboarding, and mock interviewing have been successful and made positive impacts in getting students prepared and building their confidence as they get ready to enter the tech industry. We identified obstacles such as not having the luxury of any (or limited) whiteboards in which to conduct tech interview trainings or have students practice. Still, we adapted and understood the importance of verbally communicating the thought processes and problem solving approaches candidates must do in a technical interview.

Some of the challenges shared by faculty regarding project implementation include team-work management skills, time management skills, guidelines for code review, further testing, getting buy-in from others at their home institution, and finding the time to incorporate industry practices in an already packed CS curriculum.

VI. Conclusion

In order to attract a diverse and inclusive workplace, it is important that tech companies provide access to skill-boosting development and resources so students from MSIs have wider

opportunities and are better-prepared candidates. The FIR program offers faculty a unique and up-close engagement with industry and an opportunity to align curriculum with high-quality, industry-sponsored standards, learn more about the recruitment process, engage in project-based learning and be exposed to the work culture at Google.

There are numerous strategies that we recommend tech companies, such as Google, implement to continue to achieve positive outcomes and growth, including some of the following:

- Establish programs like FIR to increase faculty awareness of industry practices
- Identify more faculty of color to participate in the FIR programs
- Create quicker design career pathways and preparedness into industry
- Provide shared principles to fill the student skills gap while graduating more students who are workforce ready
- Create synergies and/or hubs across MSIs as a consortium to engage other MSIs that are not as strong

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